Preliminary Work Plan for Lead Surveys for San Francisco Unified School District Lead Poisoning Prevention Program San Francisco, California

Version 1.0

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DOCUMENTS DEPT.

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LEAD HAZARD IDENTIFICATION AND CONDITION ASSESSMENT SURVEY

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OVERVIEW

The purpose of this Work Plan is to standardize the collection and presentation of potential lead hazard data at facilities operated by the San Francisco Unified School District (SFUSD). This Work Plan was prepared for the SFUSD Facilities Planning and Construction Department. The survey methods described herein are derived in part from Housing and Urban Development (HUD) guidelines, as well as from other sources. HUD guidelines were intended to apply only to public housing; however, they have been adapted to fit the requirements of this Work Plan. The HUD Guidelines are a valuable source of environmental standards, as they represent one of the first attempts to comprehensively address the hazards of lead-based paint.

Section 1.0 provides a typical survey scope of work, to be used by SFUSD for bidding by a qualified industrial hygiene firm.

Section 2.0 covers the use of X-Ray Fluorescence Spectrum Analyzers for in-situ lead-based paint (LBP) sampling. This section includes a discussion of radiation safety considerations, as well as interpretation of results.

Section 3.0 covers sampling and analysis procedures for bulk or paint chip sampling of lead-based paints (LBP) with laboratory analysis by atomic absorption (AA). This procedure shall be used in conjunction with the HUD Guidelines contained in "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing," prepared by the National Center for Lead-Safe Housing.

Section 4.0 covers sampling procedures for wipe sampling of lead contamination with laboratory analysis by atomic absorption. These procedures shall be used in conjunction with the HUD Guidelines contained in "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing," prepared by the National Center for Lead-Safe Housing.

Section 5.0 outlines procedures for sampling and laboratory analysis for Total Threshold Limit Concentration (TTLC) and Soluble Threshold Limit Concentration (STLC) for determination of lead-contaminated soil or waste disposal.

Section 6.0 covers sampling and laboratory testing procedures for assessing lead-contamination of soils per the HUD Guidelines.

Section 7.0 discusses the procedures for sampling and analysis of drinking water.

Section 8.0 outlines typical report content and the use of sampling forms, chain-of-custody forms, etc. It also outlines an electronic data submittal format, so that the data can easily be imported into an electronic database, should one be created.

Section 9.0 outlines typical quality assurance/quality control (QA/QC) procedures, including surveyor training requirements, surveyor and Project Manager roles, quality control analyses, etc.

Section 10.0 discusses other issues related to lead-based paint, including the possible presence of asbestos in paint, and the occupational safety implications of paint which may or may not contain sufficient lead concentrations to be categorized as lead based.

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Section 11.0 lists Applicable Standards which are referenced throughout the Work Plan.

Section 12.0 contains Standard Forms for use in this Work Plan.

The Appendix contains XRF performance characteristic sheets for a variety of XRF models.

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While the Work Plan specifies certain requirements for survey execution and the reporting of findings, it is the sole responsibility of each Environmental Consulting firm to fulfill their contract. This Work Plan should in no way be construed as limiting a surveyor's responsibility in this regard. By using any material, ideas or methods, delineated in this Work Plan, the user agrees to wholly indemnify SCA for any and all lawsuits, penalties and expenses arising from such use.

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1.0 TYPICAL SURVEY SCOPE OF WORK

A sample scope of work document follows. Detailed information about the site must be added prior to distribution to bidding firms.

Background

(NAME OF SITE) is located at (ADDRESS). (NAME OF SITE) consists of:

☐ is a ___ level building, constructed in ___, and comprises (SQUARE FOOTAGE) of usable space.

☐ (NUMBER) of playground areas.

☐ (NUMBER) of acres.

Materials to be sampled during this survey, aside from building surfaces, include play equipment, soil at the perimeter of buildings, bare soil throughout the site, sandbox fill, and drinking water. The boundaries of the site are shown on the site plan, to be provided by SFUSD. Any structures or conditions bordering the site which impact the site (i.e., paint flaking off of a wall and landing within the site boundaries) should be noted in the survey.

Construction records and previous survey records available for use in this survey include:

_____, and
_____.

Scope of Work

The lead survey of the above referenced site will include the following items:

Task 1: Document Review:

The surveyor will review building drawings and other construction documents, where available, to identify areas of concern regarding possible sources of environmental lead. In addition, the surveyor will review any existing lead survey reports prior to the survey, and incorporate the previous findings in the new report.

Task 2: Sampling:

Contact Mr. Bruce Giannini, Asbestos Program Manager at 1551 Newcomb Avenue, San Francisco, CA 94124; tel: (415) 695-5822 to schedule building access. Note that access may be difficult because of the need to collect the "first draw" water samples. Consultant's fee should include this access difficulty factor.

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A DOHS Certified Lead-Based Paint Inspector/Assessor under the direct supervision of a Certified Industrial Hygienist (CIH) will visit the site and perform sampling of the following materials:

A. Any coated surface (including ceramic tile glazing and mini-blinds) using an X-Ray Fluorescence (XRF) spectrum analyzer, or using bulk sampling with analysis by Flame Atomic Absorption (FAA), using protocols described in the Work Plan dated 5/1/97 for SFUSD;

B. Surface dust of accessible interior surfaces, using protocols described in the Work Plan dated 5/1/97 for the SFUSD. At least one wipe sample shall be collected and analyzed from the floors and window sills of every normally occupied room in the building or site. These samples shall not be composited, and sample locations and unique sample I.D.'s shall be recorded on survey drawings.

C. Soil at exterior locations in the vicinity of lead-painted surfaces, or locations where available records indicate structures were formerly located (prior to demolition), or at bare soil locations, using protocols described in the Work Plan dated 5/1/97 for SFUSD;

D. Sandbox fill, where applicable, using protocols described in the Work Plan dated 5/1/97 for the SFUSD;

E. Drinking water, using protocols described in the Work Plan dated 5/1/97 for the SFUSD;

In the field, surveyors will make use of standard forms issued by SFUSD. These forms and their use are described in the Work Plan, dated 5/1/97.

Task 3: Report Preparation

Within 30 days of completion of survey, a Survey Report will be prepared and delivered to SFUSD. The report will include an electronic data submittal, which shall follow the format specified in the Work Plan, dated 5/1/97 for SFUSD.

Prioritize results using the Priority Ranking Algorithm described in the Work Plan dated 5/1/97 for SFUSD;

Show all sample locations with corresponding sample I.D.'s on detailed drawings. For exterior samples, the site plan may be used. For interior building samples, a floor plan must be used. Obtain mylar backgrounds from Facilities Planning and Construction, Asbestos Control Program.

Field work must begin and be completed as directed by the District's Project Manager.

Task 4: Work Plan Preparation

Following the submittal of each survey report (or sooner in cases of Imminent Hazards), contact the Project Manager for the responsible City agency, to discuss the preparation of a Lead Hazard Response Work Plan. Contact Mr. Bruce Giannini, Asbestos Control Manager at (415) 695-5822 to obtain the name and phone number of the appropriate party.

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2.0 X-RAY FLUORESCENCE SPECTRUM ANALYZER

2.1 Health Effects & General Safety Precautions

X-Ray Fluorescence (XRF) Spectrum Analyzers contain a sealed source of radioactivity (e.g., Cobalt 57 or Cadmium-109), which must be handled with care. Emissions from these sources are shielded to minimize the operator's exposure, when the instrument is properly used. However, the operator must be fully aware of the hazard and the proper operation of the instrument, following the manufacturer's health and safety instructions.

Basic safety rules that apply to this instrument include the following:

- Do not operate an XRF analyzer without proper training and licensing.
- Never point the XRF Analyzer at oneself or another person. When the device is used on a wall which adjoins another room or dwelling, the inspector shall check to be certain that no one is in the adjoining space. X-rays, especially gamma rays, can go through solid objects, such as plaster or wood.
- Under no circumstances shall the XRF Analyzer be positioned such that the operator exposes eyes or genitals to direct radiation from the instrument. The analyzer should be handled carefully, since some radiation is given off even when the instrument is not in use.
- The XRF must be in the Inspector's possession at all times, either in direct sight or in an area designated secure by the State Radiological Safety Officer. The Inspector is responsible for security of the radioactive source.

Proper use of the XRF Analyzer requires a basic understanding of how radiation can affect the human body. Gamma rays from the radiation source can cause damage to body tissues. Fortunately, the amount of radiation emitted by these sources is small, and with proper use, will expose the Operator to negligible amounts of radiation.

Occupational exposures to X-rays shall not exceed the annualized limits (see Section 11.1.).

2.2 Radiation Compliance Program

SFUSD assumes that any firm using an XRF to perform a survey in accordance with this Work Plan is properly licensed to do so, and that only licensed operators will use the XRF in the field. Furthermore, SFUSD assumes that licensed firms have a Radiation Compliance Program in place. It is the responsibility of the consulting firm to comply with all licensing regulations, and to follow their internal Radiation Compliance Program protocols.

2.3 XRF Selection

The following table compares the performance characteristics of various XRF models.

Model	Source	Initial Source Strength (in mCi)	Inconclusive Range@	Bias at 1.0 mg/cm^2	Precision at 1.0 mg/cm^2
Advanced Detectors, Inc. Lead Star	Co-57	15	0.9 to 1.1-1.3 (depending on substrate)	0.0 to 0.2	0.3
Niton Corporation XL-309	Cd-109	10	None	0.0	0.3
Princeton Gamma-Tech, Inc. XK-3	Co-57	10	None (drywall) 0.4 to 1.8 (metal) 0.7 to 1.4 (plaster) 0.8 to 1.7 (concrete) 0.9 to 1.3 (Brick) 0.9 to 1.4 (wood)	0.0 to 1.3*	0.4 to 1.0
Radiation Monitoring Devices LPA-1	Co-57	12	None (Brick) None (Drywall) None (Concrete) 0.9 to 1.3 (Metal) 0.9 to 1.0 (Plaster)	-0.2 to -0.6	0.3
Scitec MAP 3	Co-57	40	None (wood) 0.2-0.9 (plaster) 0.3-0.9 (brick & concrete) 0.6-0.8 (drywall) 0.9 to 1.2 (metal)	-0.7 to 0.6	0.3 to 0.7
Scitec MAP 4	Co-57	not shown in PCS	0.9 to 1.2	0.1 to 0.5	0.3 to 0.6
TN Technologies, Inc. Pb Analyzer	Cd-109	30	0.9 to 1.1-1.3 (depending on substrate)	0.1 to 0.3 *	0.4
Warrington, Inc. Microlead I	Co-57	10	0.5 to 1.4 (concrete) 0.7 to 1.6 (plaster) 0.8 to 1.3 (brick) 0.9 to 1.1 (drywall) 0.9 to 1.4 (metal) 0.9 to 1.6 (wood)	-0.3 to 1.0	0.3 to 0.7

Source: National Lead Information Center.

* Bias varies between machines of the same model.

@ Based on HUD studies, not on statistical confidence interval.

An XRF model used for a survey pursuant to this Work Plan must meet the following two criteria:

a. The inconclusive range must be no more than +- 0.2 at 1.0 mg/cm^2 for all substrates; and

b. The peak radiation value, shutter open, must be no more than 0.6 mR/hr.

Model names in bold above meet criteria (a), and are acceptable for use provided that compliance with criteria (b) can be documented. Consultants will provide documentation to SFUSD confirming that the model meets the criteria listed above, or SFUSD may disallow the use of the model in question. Documentation must be submitted prior to the use of the XRF for an SFUSD lead survey.

2.4 Equipment and Materials Required

Typical equipment and materials required include, but are not limited to, the following:

- Clipboard with pencil or pen(s);
- Disposable latex gloves;
- Sharp cutting tool;
- Scraping tool for removing paint chips from metal surfaces;
- Polaroid camera and film with clear plastic holders;
- Swiss army knife/putty knife;
- Water spray bottle (100 cc) with amended water;
- Paper towels;
- Sharpie© marking and high-lighter pens;
- Waste container, e.g., small ziploc bags;
- Material/Sampling Data Sheets and Functional Space Data Sheets or other Inspection Forms;
- Flashlights and batteries;
- Tape measure/digital tape measure;
- Satchel or shoulder bag for carrying supplies or photographer's vest;
- HEPA-filtered vacuum, as applicable;
- Duct tape/masking tape;
- Two-mil plastic sheeting, as applicable;
- Warning signs;
- Hammer and screw driver (standard and Phillips);
- Compass;
- Notices for posting and copies of information that may be required to be distributed, as applicable; and
- Other equipment which may be provided by the Client, e.g., ladders, hand trucks, etc. (check availability in advance).

In addition to the above, XRF users shall have:

- A fully charged machine in its locked carrying case;
- Dosimetry badge and/or ring;
- Calibration materials;
- Logbook; and
- Extension cord, in case the battery charger needs to be run on-site.

If the Inspector enters a de-leading area, they must have proper training and protective gear, including the following:

- Personal protective equipment, i.e., tyvek suits, hard hat, safety shoes,

safety glasses, etc. (as needed); and
- Respirator equipped with type H or combination cartridges.

2.5 Sampling & Results Interpretation

Use of the XRF shall follow the manufacturer's sampling procedures for L-shell and K-shell readers, as appropriate.

Paint samples from different exterior and interior surfaces shall be analyzed *in-situ* to identify the presence and extent of lead-containing paints.

A. Identifying Suspect LBP

Visually inspect the area to differentiate and identify distinct, paints on the basis of its appearance (color and texture), function, and similar date of installation. Identify all homogeneous areas of all suspected LBP.

B. Sample Frequency

Select sampling locations that are representative of the suspect material and that are evenly distributed throughout the building or renovation area.

Record data using a spreadsheet (see the Forms Section) and provide descriptive information, e.g., color, etc.

Follow all relevant guidelines described in Section 3.0, including drawing preparation.

2.6 XRF Calibration

The 1.0 mg/cm^2 calibration card shall be used for calibration according to the following schedule:

- Before the start of sampling at each site;
- Following each 200 readings; and
- At the conclusion of sampling for each site.

In addition, one confirmation paint chip sample of known area shall be collected and analyzed from each site. See Section 3.2.1 for detailed sampling instructions.

3.0 PAINT CHIP SAMPLE COLLECTION

CAUTION: Paint chip samples of suspected LBP must be collected in a manner that prevents or minimizes the generation of airborne particulate matter. Select sampling locations that will disturb the materials least, e.g., the top surfaces of beam flanges and wear damage to substrates is least apparent. Wear personal protective equipment, as necessary. Ensure sampling location is left in pre-sampling condition, where feasible.

Paint chip sample collection of suspect LBP shall be completed in adherence with the HUD protocols outlined in "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing," prepared by the National Center for Lead-Safe Housing, 10227 Wincopin Circle, Suite 205, Columbia, MD 21044, dated June, 1995 (Appendix 13.3 or latest version).

3.1 Equipment and Materials Required

Typical equipment and materials required include, but are not limited to, the following:

- Clipboard with pencil or pen(s);
- Non-sterilized, non-powered disposable latex gloves;
- Sharp cutting tool;
- Scraping tool for removing paint chips from metal surfaces, such as a Proprep Scraper available at most paint stores;
- Plastic ziploc bags or mini polycon container pre-labeled (ordered from Loral Packaging in Los Angeles, CA; (800) 474-7781) [Note that ziploc bagged samples generally should be reported in µg/g or percent by weight instead of mg/cm^2];
- Polaroid camera and film with clear plastic holders;
- Swiss army knife/putty knife;
- Tweezers;
- Water spray bottle (100 cc) with amended water;
- Paper towels or disposable wipes for cleaning the paint scraper;
- Sharpie© marking and high-lighter pens;
- Waste container, e.g., small ziploc bags;
- Material/Sampling Data Sheets and Functional Space Data Sheets or other Inspection Forms;
- Flashlights and batteries;
- Tape measure/digital tape measure or ruler for reporting results in mg/cm^2;
- Satchel or shoulder bag for carrying supplies or photographer's vest;
- HEPA-filtered vacuum;
- Duct tape/masking tape;
- Two-mil plastic sheeting;
- Warning signs;
- Hammer and screw driver (standard and Phillips);
- Compass;
- Notices for posting and copies of information that may be required to be distributed, as applicable; and
- Other equipment which may be provided by the Client, e.g., ladders, hand trucks, etc. (check availability in advance).

If the Inspector enters a de-leading area, they must have proper training and protective gear, including the following:

- Personal protective equipment, i.e., tyvek suits, hard hat, safety shoes, safety glasses, etc. (as needed); and
- Respirator equipped with type H cartridges or combination cartridge.

3.2 Collection of Paint Chip Samples

A. Prepare the area for sampling:

- Isolate the space, if possible, to prevent entry of unprotected persons.
- Cover with plastic sheeting carpeting and other horizontal surfaces that might be contaminated by the sampling procedures. Select the sampling location to ensure minimal disruption to normal occupant's activities, without compromising on the representativeness of the sample.

B. Identify Suspect LBP: Visually inspect the area to differentiate and identify distinct paints on the basis of its appearance (color and texture), function, and similar date of installation. Sample loose and peeling paints inclusive of all layers, where feasible. Identify all homogeneous areas of all suspected LBP.

C. Sampling Collection: Collect representative samples representing a mix of substrates, color and conditions as outlined in the OSHA Construction Lead Standard (29 CFR 1926.62; 8 CCR 1532.1 in California). It is possible that the site may contain so many varieties of suspect lead-containing materials that comprehensive sampling may yield more bulk samples than can be analyzed within the survey budget. In this instance, the Consultant must perform the comprehensive sampling, notify SFUSD of the situation, and archive the unanalyzed samples for a period of not less than 6 months.

Select sampling locations that are representative of the suspect material and that are evenly distributed throughout the building or renovation area. A clean sheet of plastic measuring 4' x 4' shall be placed under the area to be sampled, typically. Any paint chips visibly falling on the plastic shall be included in the sample. Dispose of the plastic after each sample, by placing the sheeting in a trash bag.

Wear personal protective equipment as required during collection of samples; use new disposable gloves for each sample. Use a Swiss army knife or a razor-sharp scraper and tweezers to remove an approximately quarter-sized sample from a suspect material. place the samples in a mini polycon container, place its cap on the container, and label it with an unique I.D. number. If the suspect material is present in layers, include all layers in the sample, and note the layered condition on the Data Spreadsheet (see the Forms Section) and provide descriptive information, e.g., color, thickness, etc. The paint chip need not be greater than 2-4 square inches in size.

D. Instrument Cleansing: Clean sample collection instruments between each use by wiping it with a wet paper towel. Place used paper towel in a ziploc bag.

E. Sample logs and sample location records: Establish a log of sample numbers on the Spreadsheet (see the Forms Section) and record for each samples the location (by building, room/area, and system), and other pertinent information. Record sample locations clearly on floor plans, mechanical system drawings, structural drawings, etc. Make sure additional clean copies of these drawings are available for the report. Where floor plans are not available, record sampling and material locations on a drawing prepared in the field.

F. Surface damage repair and cleaning debris: Repair surfaces damaged by sample collection. Clean-up debris released during samples collection using either duct tape, wetted paper towels or a HEPA-filtered vacuum. Place contaminated tape and paper towels in a ziploc bag. Wet wipes shall be used to clean the area sampled or all settled dust, as required. The surface can be concealed with new paint, if necessary. Personnel conducting paint sampling shall avoid hand-to-mouth contact (specifically, smoking, eating, drinking, and applying cosmetics) and shall wash their hands with soap and water immediately after sampling. Wet wipes may be used if clean water is not readily available.

G. Sample Custody: Maintain custody over samples in accordance with standard procedures. Ship all samples to the appropriate laboratory utilizing a "Chain-of-Custody" transmittal.

3.2.1 AA/XRF Correlation Samples

At each site, a minimum of one paint chip sample shall be collected for the purpose of establishing a correlation between XRF and AA readings. These paint chip samples shall be collected in accordance with the methods described in Section 3.0, with the following modifications:

The sample shall include all layers of paint, and encompass a quantified surface area. This can be accomplished with the following procedure:

A. Place a template of known dimensions (for example, 1 cm^2) on a surface;

B. Trace the outline of the template onto the surface with a pencil;

C. Score the surface along the pencil lines with a razor blade, until all layers have been penetrated;

D. With a folded self-adhesive memo page beneath the area of the sample, to direct paint into the sample vial, scrape the area with a narrow sharp implement, so that all layers of paint are included. If the substrate is sheetrock, the sheetrock paper can be included in the sample;

E. The sample result must be analyzed for **TOTAL LEAD**, rather than

ppm. The result can then be expressed in units compatible with XRF results (mg/cm^2).

3.3 Laboratory Analysis

3.3.1 Laboratory Qualifications

All laboratories involved in analyzing the field samples, including the field duplicates, spiked, external laboratory QC samples, arbitration samples, etc., must maintain these accreditations for lead-based paint (LBP) identification:

A. EPA National Lead Laboratory Accreditation Program (NLLAP) certification;

B. NIOSH/EPA Environmental Lead Proficiency Analytical Testing Program (ELPAT) certification; and

C. California Department of Health Services (DOHS) Environmental Laboratory Accreditation Program (ELAP) certification (within California).

3.3.2 Laboratory Data Management

The Laboratory shall generate a hard copy of the Laboratory Data Sheet, signed and approved by the Laboratory Director. The Consultant will incorporate this report into the Building Survey Report.

3.3.3 Sample Chain of Custody Forms, Laboratory Log-In, Shipping and Archival

Inspectors will submit samples with a "Chain-of-Custody" form, which includes field sample I.D. numbers, the sample collection date, identification of the analysis required, the method reference, and pertinent administrative information. The Chain-of-Custody form must also have spaces for the signatures of all who handle the samples, and the dates of transfer. The initial signature is that of the Field Surveyor relinquishing the samples.

Shipping of samples must comply with the Department of Transportation (DOT) requirements (Hazardous Material Regulations, 40 CFR Part 107 and 171-180, Dec., 1990).

Upon receipt of the samples, the laboratory's representative will review the Chain-of-Custody form, and compare the completeness of the information against the samples received. If information is incomplete, such as missing samples, mismatched sample identifications, etc., the laboratory shall reject the shipment and return the package to the Inspector. Correcting information on the Chain-of-Custody form, or sample identification based on telephone discussion is considered unacceptable. The Inspectors will then re-submit the Chain-of-Custody form with the samples after confirming and correcting the information on the forms.

The laboratory will assign unique, sequential laboratory numbers to the samples. This sequential number will be used exclusively by the laboratory for tracking, including assignment to the analysts, recording of data in an analyst's

laboratory notebook, glass slides, etc. The laboratory will keep the Chain-of-Custody form in a job folder.

A copy of the completed Chain-of-Custody form shall be returned to the Consultant for filing and inclusion in the Building Survey Report.

The Consultant will ensure that all samples, analyzed or not, are archived for a period of 6 months. If samples are being shipped back to SFUSD or the Consultant for archival, shipping must comply with the same DOT requirements as stated above, and accompanied with proper Chain-of-Custody forms.

3.3.4 Laboratory Methods

Bulk or paint chip analyses shall be completed by Atomic Absorption using EPA method 600/8-91-213.

4.0 LEAD WIPE SAMPLING

Wipe sample collection of settled dust shall be completed in adherence with the HUD protocols outlined in "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing," prepared by the National Center for Lead-Safe Housing, 10227 Wincopin Circle, Suite 205, Columbia, MD 21044, dated June, 1995 (Appendix 13.2 or latest version). For further information, contact ASTM ES 30-94 for additional procedures. Adhere to the HUD 1-hour waiting period rationale for clearance wipe sampling, as applicable.

4.1 Equipment and Materials Required

Equipment required shall include, but is not limited to, the following:

- Clipboard with pencil or pen(s);
- Disposable latex gloves, non-sterilized and non-powered, required to prevent cross-sample contamination;
- Masking tape to define the wipe area;
- Water spray bottle (100 cc) with amended water;
- Paper towels;
- Sharpie© marking and high-lighter pens;
- Single thickness filter paper or non-alcohol "baby" or respirator wipe, durable and not easily torn and digestible within the Laboratory complying with ASTM Standard ES 30-94 [blank media shall not contain more than 25 µg/wipe, the Detection Limit using Flame Atomic Absorption; do not use Whatman filters or baby wipes with aloe] [acceptable products include "Little Ones Baby Wash Cloths," "Little Ones Baby Wipes Natural Formula," and "Little Ones Baby Wipes Lightly Scented" available at K-Mart; "Wet Wipes" available at Walgreens and other stores,; and "Pure and Gentle Baby Wipes," Fame Baby Wipes," and "Wash'n Dri Wipes"];
- Sample container, e.g., polyethylene centrifuge tubes (50 ml size), or equivalent hard shell container;
- Waste containers, such as plastic trash bags or ziploc bag;
- Field Data Spreadsheet and other Inspection Forms;
- Flashlights and batteries;
- Tape measure or ruler;
- Satchel or shoulder bag for carrying supplies or photographer's vest; and
- Other equipment which may be provided by the Client, e.g., ladders, hand trucks, etc. (check availability in advance).

4.2 Wipe Sampling Procedures

The Department of Housing and Urban Development (HUD) has issued guidelines for assessing lead-based paint hazards in its document "Guidelines for Evaluation and Control of Lead-Based Paint Hazards in Housing," prepared by the National Center for Lead-Safe Housing, 10227 Wincopin Circle, Suite 205, Columbia, MD 21044, dated June, 1995 (or latest version). The HUD Guidelines, as they will be referred to herein, suggest the collection of wipe samples before and after lead abatement to determine surface contamination with specific recommendations for collection procedures and the number and

location of samples for lead abatement projects. OSHA's Technical Manual also lists a wipe sampling procedure for determining surface contamination in the work place.

To collect a wipe sample, place an area template of approximately 12" x 12" per the HUD Guidelines on the surface to be sampled. Wipe the entire area with the recommended filter paper or commercial wipe. Place the wipe in a clean sample vial and cap the top. Send the samples to a qualified laboratory for lead analysis. See Section 11.7 for applicable standards.

Inspectors will submit samples with a "Chain-of-Custody" form, which includes field sample I.D. numbers, the sample collection date, identification of the analysis required, the method reference, and pertinent administrative information. The Chain-of-Custody form must also have spaces for the signatures of all who handle the samples, and the dates of transfer. The initial signature is that of the Field Surveyor relinquishing the samples.

4.2.1 Floors

At least one wipe sample shall be collected and analyzed from the floors of every occupied room in the building or site. These samples shall not be composited, and sample locations and unique sample IDs shall be recorded on survey drawings.

Identify the area to be wiped, but do not touch the wipe area. Apply masking tape to perimeter of area for form a square or rectangle of 1 sq. ft. Inspect the wipes to determine if they are moist; do not use if dried out. Typically the first wipe in a pop-up container shall be disposed of. Rotate the wipe container before starting to ensure liquid inside contacts the wipes.

Prepare the vials, partially unscrewing or uncapping. Wearing a disposable glove on one hand, place the wipe at one corner of the surface to be wiped with the wipe fully opened and flat to the surface. Complete a first pass, using an S-pass, pressing firmly with the palm of the gloved hand. Exerting too little pressure will result in poor collection of dust. Exerting excessive pressure will cause the wipe to curl or tear. Fold the wipe in half with the contaminated side facing inward, and repeat the wipe using an S-pattern in the perpendicular direction, attempting to remove all visible dust. After wiping, fold the wipe with the contaminated side facing inward again, and insert aseptically (without touching anything else) into the centrifuge tube or other hard-shell container. If gross debris is present, such as paint chips, make every attempt to include as much debris as possible in the wipe.

Seal the tube and label with the appropriate identifier, completing the material sampling data sheet and chain-of-custody forms. Record the area of the measured wipe, measuring at minimum 4" x 4", or 0.1 SF.

4.2.2 Window Sills and Other Rectangular Surfaces

Window wipe samples shall be collected if lead-paint or paint which is suspected to be lead is present on window components. One composite sample consisting of no more than four wipes shall be collected of representative lead-painted window sills. In addition, a separate composite sample shall be

collected for window troughs for lead-painted operable windows.

If the surface is rectangular, such as a window sill, two side-to-side passes must be made over half of the surface, folding the wipe inward for the second pass. Do not attempt to wipe the irregular edges presenting the contour of the window channel. Wipe and chain-of-custody procedures shall be similar to those defined for floors above. If heavily dust-laden, a smaller area shall be wiped, measuring not less than 0.1 SF (approx. 4" x 4").

4.2.3 Blanks

Field blanks determine if the sample media is contaminated. Each field blank shall be labeled with a unique identifier, labeled so that the laboratory is not aware of which sample represents the blank.

Blank wipes are collected by removing a wipe from the container with a new glove, shaking it wide open, and refolding as under the actual sampling procedure. Insert the inwardly folded blank into the centrifuge tube without touching other surfaces or objects. Sample one blank per school per day, one blank per day, or one blank every 50 samples per the HUD Guidelines, whichever is most frequent. After sampling, the Surveyor shall thoroughly wash their hands with soap and water, or use a wet wipe to clean his/her hands.

4.3 Laboratory Analysis

4.3.1 Laboratory Qualifications

All laboratories involved in analyzing the field samples, including the field duplicates, spiked, external laboratory QC samples, arbitration samples, etc., must maintain these accreditations for lead-based paint (LBP) identification:

A. EPA National Lead Laboratory Accreditation Program (NLLAP) certification; and

B. NIOSH/EPA Environmental Lead Proficiency Analytical Testing Program (ELPAT) certification; and

C. California Department of Health Services (DOHS) Environmental Laboratory Accreditation Program (ELAP) certification (within California).

4.3.2 Laboratory Data Management

The Laboratory shall generate a hard copy of the Laboratory Data Sheet, signed and approved by the Laboratory Director. The Consultant will incorporate this report into the Building Survey Report.

4.3.3 Laboratory Methods

Wipe sample analyses shall be completed using one of the following approved methods:

- flame atomic absorption (AA); and

- graphite furnace atomic absorption (AA).

5.0 LEAD WASTE CHARACTERIZATION

5.1 Evaluating Waste

Prior to disposal of lead debris or contaminated soil, or of demolished building components, characterization and testing of loose and peeling paint chips, soils, sands and architectural components are required, testing for hazardous waste and solubility must be conducted per Chapter 11, Division 4.5, Title 22 of the California Code of Regulations (22 CCR). Waste characterization is dependent, in part, on the physical characteristics of the waste. For example, when lead-based paints or lead glazing are bonded to the building materials, a generator should consider the ratio of mass of all materials in the waste to the lead content of the paint when determining the hazardous waste classification of intact demolition debris. However, if during the demolition or dismantling of the building(s), the paint is separated from the lead-coating is separated from the building materials (e.g., chemically or physically removed), then these coatings and loose wastes shall be evaluated independently from the building materials to determine its proper management.

Segregate waste and test independently, where feasible, for hazardous waste minimization (e.g., plastic sheeting, used coveralls, and paint chips).

5.2 Analytical Methods

The following analytical methods are used to determine the hazardous characteristics of lead waste:

A. SW846: Required by California to establish total lead in the material, for comparison against the Total Threshold Limit Concentration (TTLC).

B. Waste Extraction Test (WET): Required by California to establish leachable lead content, for comparison against Soluble Threshold Limit Concentration (STLC).

D. Toxicity Characteristic Leaching Procedure (TCLP): Federally required to establish leachable lead content for comparison against STLC.

See Section 11.5 for a discussion of these methods and the applicable standards.

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6.0 SOIL SAMPLING

6.1 Equipment and Materials Required

Equipment required shall include, but is not limited to, the following:

- Clipboard with pencil or pen(s);
- Non-sterilized, non-powdered disposable latex gloves, e.g., Action Scientific (800-678-1033) No. A-105;
- Non-sterilized plastic ziploc bags or plastic vials with lids [double bag all samples unless baggies are 4-mil or better];
- Stainless-steel or equivalent (lead-free) coring device or hand shovel/scoop;
- Polaroid camera and film with clear plastic holders;
- Masking tape;
- Water spray bottle (100 cc) with amended water;
- Paper towels or wet wipes;
- Sharpie© marking and high-lighter pens;
- Waste container, e.g., small ziploc bags;
- Field Data Spreadsheet and other Inspection Forms;
- Flashlights and batteries;
- Tape measure or ruler;
- Satchel or shoulder bag for carrying supplies or photographer's vest; and
- Other equipment which may be available at the site, e.g., ladders, hand trucks, etc. (check availability in advance).

If the Inspector enters a de-leading area, they must have proper training and protective gear, including the following:

- Personal protective equipment, i.e., tyvek suits, hard hat, safety shoes, safety glasses, etc. (as needed); and
- Respirator equipped with type H cartridges or combination cartridge.

6.2 Soil or Sand Contamination Testing

Soil sample collection shall be completed in adherence with the HUD protocols outlined in "Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing," prepared by the National Center for Lead-Safe Housing, 10227 Wincopin Circle, Suite 205, Columbia, MD 21044, dated June, 1995 (Appendix 13.4 or latest version). Check/verify which sampling protocol shall be followed for a particular survey. For further information, contact ASTM ES 29-94 for additional procedures. Soil sample collection shall also comply with SFDPH protocols outlined in "1625-Soil Sampling Methods and Analyses" prepared by the Childhood Lead Prevention Program, 1390 Market Street, Suite 230, San Francisco, CA 94102. The standard presented here is an amalgam of various sources, including the two stated above.

Bare soil samples are usually collected with a coring device or a scooping technique. Coring tools shall be twisted to push through soils and roots in packed earth at least to 1/2-inch depth. In softer soils, scooping methods shall be used. Transfer soils to a sample container. Follow the HUD Guidelines for

composite sampling procedures.

Decontaminate the scoop or coring device after each sample, wiping with a wet wipe or wet paper towel until no dirt is visible.

In general, composite samples will be collected. If an area with obvious soil contamination is encountered, an individual sample may be collected at that location. Otherwise, follow the soil sampling protocol given in Appendix 13.3 of the HUD Guidelines (supplied in Appendix B to this document). In addition, observe the following requirements:

- Avoid sampling areas obstructed by vegetation, concrete, bricks, asphalt, twigs, stones, or gross debris. If a selected sampling location is obstructed, select the nearest alternative location as close as possible to the original location;
- The surface of the soil will not be altered prior to sampling. Organic matter or a surface mat of decayed grass or leaves will not be discarded from samples, as lead is usually absorbed more readily by organic than inorganic matter;
- One composite roadside sample shall be collected from each site which adjoins a road. Samples shall be collected along an imaginary 1-meter diameter circle at the 3, 6, 9 and 12 o'clock positions, with the 6 o'clock position directly adjoining the roadside, and the 12 o'clock position 1 meter away from the roadside. This process shall be repeated for each road adjoining the site, and all samples shall be composited as a single sample.
- An aliquot will be taken from 10% of samples for blind duplicate analysis.

6.3 Laboratory Analysis for Sand and Soil Samples

Send the samples to an EPA NLLAP-accredited laboratory for lead analysis. Roadside samples shall be analyzed for the following metals:

- lead,
- ~~arsenic~~,
- ~~boron~~,
- ~~chromium~~,
- ~~iron~~,
- ~~manganese~~,
- ~~potassium~~,
- ~~sodium~~,
- ~~tin~~,
- ~~zinc~~.
- ~~aluminum~~,
- ~~barium~~,
- ~~cadmium~~,
- ~~cobalt~~,
- ~~lithium~~,
- ~~molybdenum~~,
- ~~selenium~~,
- ~~strontium~~,
- ~~titanium~~,
- ~~antimony~~,
- ~~beryllium~~,
- ~~calcium~~,
- ~~copper~~,
- ~~magnesium~~,
- ~~nickel~~,
- ~~silver~~,
- ~~thallium~~,
- ~~vanadium~~, and

Analysis shall be performed by EPA method 6010.

The laboratory will be instructed to remove all foreign objects from the soil samples prior to analysis (e.g., metal objects such as bolts, nuts, wire; rubber and ceramic pieces; rocks of gravel size and larger, etc.)

Completed Chain of Custody forms will accompany field samples at all times including transit to the laboratory. Forms will be signed, dated, and time marked prior to being relinquished by each responsible party.

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6.4 XRF Soil Analysis

If any XRF is used for performing bulk soil analysis, follow the soil sample collection guidelines as previously stated, except:

- Forward bulk sample for laboratory AA analysis in cases where XRF readings are inconclusive (for example, if the confidence interval is so large that it cannot be determined whether a result is above or below the relevant standard); and
- Forward every 10th sample for laboratory AA analysis for confirmation purposes, or at least one sample/site.

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7.0 DRINKING WATER SAMPLING

7.1 Equipment and Materials Required

Equipment required shall include, but is not limited to, the following:

- Clipboard with pencil or pen(s);
- Non-sterilized, non-powdered disposable latex gloves, e.g., Action Scientific (800-678-1033) No. A-105;
- New, non-sterilized plastic 250-milliliter to 1-liter bottles with screw-on caps [bottles prepared with nitric acid shall be used where lab delivery and analysis is not expected to be immediate.];
- Sharpie© marking and high-lighter pens;
- Flashlights and batteries;
- Satchel or shoulder bag for carrying supplies or photographer's vest; and

7.2 Drinking Water Lead Contamination Sampling

Water samples collected at each site will be the "first draw" water, collected in the morning prior to the arrival of any staff. The purpose is to allow for a "worst case scenario" in terms of leaching of lead into water from plumbing and fixtures. Water should be unused for a minimum of 6 hours prior to sampling. Speak to the site contact prior to the date of the survey, to find out when building occupants arrive, and if necessary, to select a day when it is feasible to have a 6-hour time with no water usage. One sample should be collected from each accessible drinking water source, including drinking fountains and kitchen sinks. If drawing water from sinks, sample cold water.

To sample, remove the cap from the 1-liter plastic sampling bottle, and slowly fill the container. **DO NOT USE ANY WATER IN THE BUILDING UNTIL AFTER SAMPLING IS COMPLETE, INCLUDING TOILET FLUSHING.**

7.3 Water Sample Analysis

Water samples will be analyzed by Graphite Furnace Atomic Absorption in accordance with EPA Method 289.2 (EPA-600/4-79-020).

Completed Chain of Custody forms will accompany field samples at all times including transit to the laboratory. Forms will be signed, dated, and time marked prior to being relinquished by each responsible party.

Laboratories performing the analysis must be certified by the California Department of Health Services for water quality analysis. The California Department of Health Services requires certified laboratories to participate in EPA water performance testing.

See Section 11 for a discussion of applicable standards.

8.0 REPORTS AND FORMS

8.1 Use of Forms

Following is a list of forms to be used in the field during the survey, as well as a description of each:

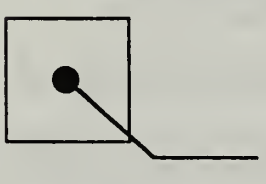
A. A spreadsheet containing all of the fields shown on the Appendix C Electronic Data Submittal.

B. Building Description Form: This form is used to describe the building or site, including the address, the age of construction, its primary usage, and any architectural features which are relevant to the survey.

C. Notice of Imminent Danger: This form is used to notify SFUSD if, during the course of a survey, a situation is observed in which the health and safety of building occupants is immediately threatened. An example would be if lead paint debris were observed in a children's play area.

8.2 Reports and Drawings

Within 30 days of completion of a survey, the Consultant will deliver a survey report to SFUSD. The report will include a drawing showing sample locations. For buildings, the drawing will show in which rooms the samples were collected. An example of a simplified drawing is shown below:



The sample label shall include the unique sample .ID. number as well as the priority code for the sample. The background drawing may be derived from drawings provided by SFUSD, but a drawing must be prepared by the surveyor if no drawing is provided.

Reports will be formatted to conform with the following sample Table of Contents:

Executive Summary (to include a landscape-formatted table listing positive and negative determinations, minimum near-term action recommendations, locations, etc. See Appendix E for example)		
1.0	Background	
	1.1	Site Description
	1.2	Data Existing Prior to Survey
	1.3	Personnel Qualification
2.0	Survey Method/Field Program	
	2.1	Priority Ranking System
	2.2	Determination Methods
	2.2.1	Lead-Based Surfacing
	2.2.2	Lead-Contaminated Soil
	2.2.3	Lead-Contaminated Drinking Water
	2.2.4	Laboratory/In-situ Analysis
	2.2.5	Accepted Data from Previous Surveys
3.0	Discussion of Results	
4.0	Recommended Management Actions	
Appendix A	Summary Table: Lead Data*	
Appendix B	Laboratory reports and Signed Chains of Custody	
Appendix C	Notices of Imminent Danger	
Appendix D	Survey Drawing	
Appendix E	Lead Data and Report Electronic Submittal (Submitted in 1.4MB diskette)	

*The Lead Data Summary Table in Appendix A is a printed copy of the Lead Data Electronic Submittal.

8.3 Assigning Priority Codes

Each sampled material will be assigned a priority, based on various criteria including lead content, space usage, the condition of the material, etc. Priorities are to be determined using the following algorithm decision tree:

Priority	> 1 mg/cm^2 or >0.5 mg/kg	>600 ppm	Soil/Surface/ Water contamination	Loose/ Peeling	Space / Object used by children	Child Access-ible
P1	Y			Y	Y	
P1			Y		Y	
P2	Y			Y	N	
P2			Y		N	
P3	Y		N	N	Y	Y
P4	Y		N	N	Y	N
P5	Y		N	N	N	
P6	N	Y	N			
P7	N	N	N			

Y=YES
N=NO

Note: Blank cell = N/A

The Decision Tree is provided in graphical form in Appendix D.

A qualitative discussion of the various priorities is provided below:

Priority	Hazard Potential to Children	Interpretation	Near-Term Recommended Actions
1	existing	loose and peeling paint or soil/surface/water contamination in a space used by children	clean-up if it's dust; stop water usage or implement flushing program if it's water; block access by children if it's loose and peeling paint or soil contamination; warn staff.
2	existing	loose and peeling paint or soil/surface/water contamination in a space NOT used by children	stop water usage or implement a flushing program if its water; ensure that the space is not used by children; warn staff.
3	limited potential	Intact lead-based paint in a space used by children, and paint is accessible to children	Inform staff of general results
4	limited potential	Intact lead-based paint in a space used by children but paint not accessible to children (based on height)	Inform staff of general results
5	limited potential	Intact lead-based paint in a space not used by children	Inform staff of general results
6	generally considered none	<5,000 ppm or 1 mg/cm^2 (HUD standard) but >600 ppm lead in paint	Inform staff of general results; Communicate occupational health implications to maintenance staff for certain tasks.
7	none	<600 ppm lead in paint	Inform staff of general results.

For sampling performed via XRF, the lowest priority which can be accurately assigned to a surface is Priority 6. Priority 7 shall be assigned only in cases where a bulk sample of paint has been collected and analyzed, with results below 600 ppm.

The information necessary for assigning priorities shall be collected in the field by the surveyor, at the time of the survey. Priorities are to be assigned for every material sampled, including soil and water samples. The site as a whole will then receive a priority code equal to the highest priority material therein.

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8.4 Electronic Data Format

Submit these two types of electronic data:

A. A spreadsheet in the Microsoft Windows Excel 5.0 text format with the fields as shown in Appendix C.

B. Word processing file for the text of the report in Microsoft Windows Word 6.0 format.

Submit on an IBM-compatible formatted High Density (1.4 megabyte capacity) diskette, or via e-mail with proper file attachment protocol, if SFUSD develops a system to receive e-mailed files in the future. Consultants are responsible for obtaining any necessary computer equipment or software.

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9.0 Quality Assurance and Quality Control

This section addresses various Quality Assurance and Quality Control (QA/QC) issues. QA/QC issues include training and qualifications of personnel, qualifications of the laboratories, the various field and laboratory QC procedures, the report review, etc.

9.1 Staff Training

The principles of training shall include the following:

A. to ensure that all Inspectors are properly trained in SFUSD's nomenclature, sampling requirements, etc. Minimum qualifications of the Inspectors shall be incorporated into the Building Survey Report.

B. to ensure that the work product is done well the first time, without having to resurvey sites.

Field Technicians will receive DOHS-approved Inspector and Project Monitor training as well as 8-hour annual refresher training. Surveyors using X-Ray Fluorescence devices will receive manufacturer's 24-hour or 48-hour training for these radioactive sources, as applicable.

Site Inspectors are required to demonstrate a thorough understanding of the Project's requirements as presented in this Work Plan. Such requirements include the proper use of forms, sampling approaches, etc.

9.2 Field Personnel Qualifications

The following table lists the typical qualifications required of the various personnel involved in asbestos surveys

Qualifications	CIH	Inspectors
1. Diplomat of the American Academy of Industrial Hygiene (CIH)	Project Manager & Sr. Consultant	
2. DOHS Accredited Inspector/Assessor		• Radiation Safety Training and Licensed Operator for XRF Usage (as applicable) • EPA Lead Inspector; • EPA Project Monitor (as applicable for clearance wipe sampling); • 1 year minimum field experience.
3. Participated in Site Specific Training & Preparation Program	yes	all Inspectors, as applicable

9.3 Other QA/QC Procedures

A. Contamination Control: Exercise these good housekeeping practices to

minimize the chances for contamination:

- Place each sample into a new, clean sampling vial or ziploc bag;
- Wipe off sampling tools after each use;
- Dispose of all contaminated materials properly;
- Maintain the sampling and laboratory in a clean and neat condition.

B. XRF samples falling within the non-conclusive range will require confirmation sampling and analysis by atomic absorption. Consult the Project Manager for site specific requirements.

C. For XRF L-shell readings <1.0 mg/cm^2, one of two actions must be taken:

1. A confirmatory paint chip sample can be collected; or
2. Use the following chart to decide whether a K-shell reading is required (for a Niton XRF):

Peak Present?		Niton XRF Confidence Interval	Depth Index @	K reading needed?
Lα (10.5 Kev)	Lß (12.6 Kev)			
Yes	Yes	±0.2	1-9	No
No or weak	Yes	±***	>8	Yes

@ The Depth Index is a unique parameter for only the Niton manufactured XRF that measures absorption and gives a reasonable qualitative indication of paint thickness.

9.4 Summary of QA/QC Requirements

Quality control procedures for smaller scale surveys are presented in Table 9.4-1 on table below:

TABLE 9.4-1
QUALITY ASSURANCE/QUALITY CONTROL ASSIGNMENTS

Item	Task	Completed by:
Preparation	Pre-Field Training & Instructions	Project Manager (PM)
	Personal Kit & Sampling Vials	Surveyor
	Site Coordination w/Client, Bldg. Engr. & Security	Surveyor
	Lab Selection & Fee Schedule	Project Manager
	Drawing/Plan Review	Surveyor w/CIH, if possible
Field Survey & Sample Data Collection	Material/Sampling Data Sheet	Surveyor
	Functional Space Data Sheet	Surveyor
	Quality Control Samples (varies)	Check w/PM
	Self QC	Surveyor
Condition/ Risk Assessment	Risk Assessment Algorithm Decision Tree	EPA Project Designer; check w/PM, if required
Laboratory Analyses	Lab Notification & Shipping	Surveyor
	Chain of Custody Forms	Surveyor
	QA/QC Analyses, including AA analyses for QC (if required)	Check w/Project Manager
Report Preparation	Cost Estimate	CIH, EPA Project Designer, or PM
	Data Processing & Draft Report	Surveyor or Team Leader
	Final Report	PE or CIH
	Plans and Figures	Surveyor or CADD Operator

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10.0 OTHER ISSUES

10.1 Asbestos in Paint

Asbestos has sometimes been used as an ingredient of paint. Asbestos is a known carcinogen, and has been linked to some forms of lung disease. Even though a painted surface may not be considered lead-based, it may contain asbestos. Further, a lead-based paint may also contain asbestos. A separate asbestos survey must be performed prior to remodeling or demolition of any structures, and should include any textured or exterior paint (as much as 1/3rd of exterior paints on concrete and stucco substrates sampled by SCA contain asbestos).

10.2 Lead Dust in Ductwork

Oftentimes, lead dust can be found in significant quantities inside ductwork. It is likely that lead emissions from automobiles (when leaded fuel was used) have settled into older ductwork over many years. While the presence of lead dust in ductwork does not pose an inherent exposure threat to building occupants, the likely presence of the lead should be accounted for prior to any duct maintenance or demolition which would impact the material. The possible presence of other heavy metals, such as cadmium, should also be considered.

10.3 Lead Concentrations Below the HUD Guideline - Occupational Health Implications

Surfacing with lead concentrations below the HUD threshold for lead-based paint (see Section 10.3 and table on following page) may still pose an exposure risk for tradespeople whose activities impact the material. CalOSHA worker regulations concerning lead must be followed even if a surfacing is non-lead by HUD criteria. The following table models the risks of lead exposure for various activities and with various lead contents based on surface density. The table is for informational purposes only, and is based on draft CalOSHA information which was not formally adopted. As of March 1997, CalOSHA has proposed 600 ppm as the standard to define a paint as lead-containing, or not. However, certain activities would still cause measurable or even significant occupational exposure, or surface contamination that exceeds the HUD wipe sampling standard.

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Table 10.2-1
Projected Airborne Exposures Vs. Lead Content per Activity Classes

	Surface Density: µg/cm²			g/shift
Type of Work	**Activity Class I**	**Activity Class II**	**Activity Class III**	**Activity Class IV**
Welding/Torching	3.2	0.64	0.12	
Dry Pressure Blasting	7.7	1.5	0.31	
Dry Removal w/ Power Tools	219	44	26	
Spray Coating	1000	205	41	>10 g/shift
Wet Removal w/Power Tools	3000	500	100	>10 g/shift
Wet Pressure Blasting	9000	2000	400	>10 g/shift
Heat Gun	15000	3000	615	>10 g/shift
Dry Removal w/Manual Tools	21000	4000	1000	>10 g/shift
Wet Removal w/Manual Tools	256000	5000	1000	>10 g/shift

	Duration: >minutes/shift			
Type of Work	**Activity Class I**	**Activity Class II**	**Activity Class III**	**Activity Class IV**
Welding/Torching ≥1000 µg/g	30	0.1		
Mechanical Abrasion		30	0.1	
Use of molten lead and solder			30	0.1

Type of Work	**Unit or Condition**	**Activity Class I**	**Activity Class II**	**Activity Class III**	**Activity Class IV**
Clean-up	Clean-up of Activity	II	III	III	
Assembly / Disassembly	Clean-up of Activity	II	III	III	
Sample Collection	Clean-up of Activity				?

Respiratory Protection Required		Type C	PAPR	1/2 face	

11.0 APPLICABLE STANDARDS

This section summarizes the various applicable standards.

11.1 Occupational Exposures - X-Rays

Where an XRF device is used, there is the possibility that the Operator may be exposed to X-rays. Occupational exposures to X-rays shall not exceed the following annualized limits:

Location/Population	Annualized Occupational Limits
Whole Body	1.25 REM/Quarter and 5.0 REM/Year
Extremities	18.75 REM/Quarter and 50 REM/Year
Minors (18 yrs. old)	10% of Adults
Embryo/Fetus	0.5 REM over gestation period applied evenly "for woman who have declared their pregnancy to their employer"
Public	0.1 REM/Year and 0.002 REM/Any Hour

11.2 Definition of Lead Based Paint Sampled by XRF

The definition of lead-coated surface, as sampled by XRF, is as follows:

Method	Standard
XRF Sampling	1.0 mg/cm^2 per HUD definition

To account for the statistical errors of the XRF measurements, the results are classified as confirmed LBP, inconclusive, and non-LBP based on the Performance Characteristics Sheet of the instrument. Inconclusive LBP should be further sampled and analyzed using AA analysis.

Note that the above categorization applies only to the HUD Standards. OSHA and Cal/OSHA do not have a similar cut-off. For all practical purposes, any lead levels, including <0.1 mg/cm^2 can potentially create an occupational exposure if inadequate dust control procedures are used. Note also Cal/OSHA's minimum level of 600 ppm defining lead paints and activities still requires dust controls for "trigger 1" activities, such as manual scraping and sanding and demolition of painted substrates to comply with the CalOSHA Construction Lead Standard (8 CCR 1532.1).

11.3 Definition of Lead-based Paint Analyzed by Atomic Absorption

Analysis Method	Standard
Flame or Furnace Atomic Absorption	5,000 µg/g or 0.5% by weight per HUD definition
Flame or Furnace Atomic Absorption	<600 ppm for non-lead-based paints per Consumer Products Safety Counsel
Flame or Furnace Atomic Absorption	<600 ppm for non-lead-based paints per SFDPH Childhood Lead Poisoning Prevention Program.
Flame or Furnace Atomic Absorption	<600 ppm rumored CalOSHA standard

11.4 Correlation of XRF and AA Sampling Results

Lead-Based Paints (LBP) are defined in the "Lead Exposure Reduction Act (October 29, 1992) as "paint or other surface coatings that contain lead in excess of 1.0 mg/cm^2, or 0.5% lead by weight." "Lead-free" paint on the other hand, is generally regarded as any dried coating containing no more than 0.06% (600 ppm) lead, meaning that no lead is added at any point in the manufacturing process (per CPSC).

A frequent question encountered is whether a correlation exists between XRF readings and results from testing by flame or furnace atomic absorption (AA), and can the XRF be used to determine the absence of lead-based paints (i.e., lead levels below the Consumer Products Safety Council limit of 600 ppm). On one hand, these two measurements are inherently different since the XRF measures a 2-dimensional value (mg/cm^2) and AA measures a 3-dimensional value (mg/kg or ppm). As a result, in most cases, poor correlation exists between XRF and AA results unless the thickness and density of the paint tested are known. XRF determination of non-lead based paint status for compliance purposes with the rumored CalOSHA Construction Lead Standard limit of 600 ppm is difficult unless paint thicknesses exceed the limits highlighted in the Table below. Results presented herein are based on an estimated average industrial paint density (D) of 1.6 mg/cm^3 (reported by NITON). The value for the corresponding reading in ppm (P), is determined from the equation given on the following page. For example, an XRF reading of 0.1 mg/cm^2 can fall below the CPSC level of 600 ppm if the thickness is 0.1 centimeters or greater, considered to be a fairly thick coating.

The best way to correlate XRF and AA results is to collect paint chip samples of a known area, as specified in Section 3.2.1. Still, it is possible for some residual paint to remain on the substrate, and not be picked up in the AA analysis.

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Table 11.4-1
Correlation of XRF and AA Results

Thickness (in)	Thickness T (cm)	X (mg/cm^2)	P (ppm)*	P (%)
0.006	0.015	0.1	4101	0.41
0.012	0.030	0.1	2051	0.21
0.024	0.061	0.1	1025	0.10
0.048	**0.122**	0.1	513	0.05
0.006	0.015	0.2	8202	0.82
0.012	0.030	0.2	4101	0.41
0.024	0.061	0.2	2051	0.21
0.048	0.122	0.2	1025	0.10
0.006	0.015	0.4	16404	1.64
0.012	0.030	0.4	8202	0.82
0.024	0.061	0.4	4101	0.41
0.048	0.122	0.4	2051	0.21
0.006	0.015	0.8	32808	3.28
0.012	0.030	0.8	16404	1.64
0.024	0.061	0.8	8202	0.82
0.048	0.122	0.8	4101	0.41
0.006	0.015	1	41010	4.10
0.012	0.030	1	20505	2.05
0.024	0.061	1	10253	1.03
0.048	0.122	1	5126	0.51
0.006	0.015	1.2	49213	4.92
0.012	0.030	1.2	24606	2.46
0.024	0.061	1.2	12303	1.23
0.048	0.122	1.2	6152	0.62
0.006	0.015	1.6	65617	6.56
0.012	0.030	1.6	32808	3.28
0.024	0.061	1.6	16404	1.64
0.048	0.122	1.6	8202	0.82

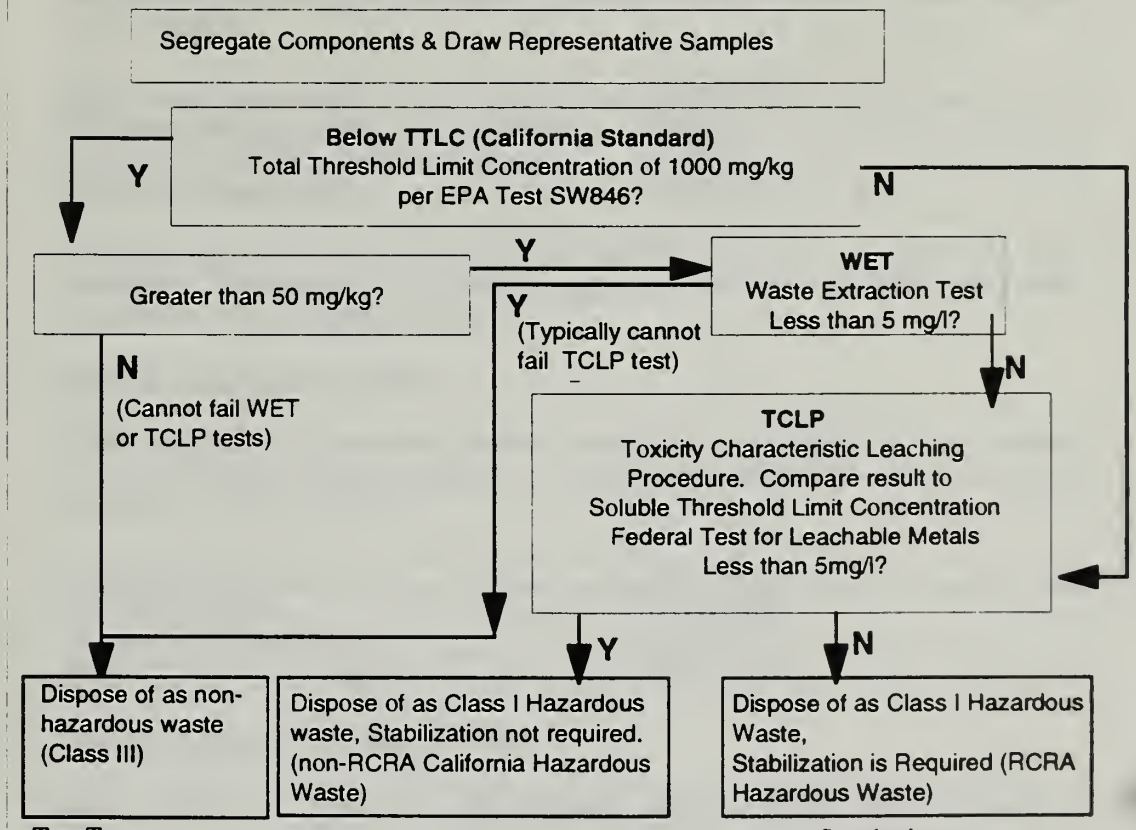
*P = (X)(1,000,000) / (T*D*1,000), where
D = the average paint density of 1.6 mg/cm^3
X = the XRF Reading in mg/cm^2; and
T = the thickness in cm.

As a supplement to the above table, Cal/OSHA's modeling data on airborne exposures to lead related to surface lead content and various construction activities are summarized in Section 9.2. This information was proposed by CalOSHA, but was not included in the final standard. Even so, it is a useful guide. In summary, worker exposure is more heavily dependent on the work control and methods than the lead content, thus requiring prudent dust control measures for even low levels of paint lead content, at levels far below the HUD standard of 1.0 mg/cm^2 (1000 $\mu g/cm^2$). Even for paint that contains <600 ppm of lead, significant occupational exposure may occur under certain condition, such as welding.

11.5 Testing for Waste Characterization

Following is a flow-chart for characterizing lead waste for disposal purposes:

Characterization of Lead Waste


Segregate Components & Draw Representative Samples
Below TTLC (California Standard)
Total Threshold Limit Concentration of 1000 mg/kg per EPA Test SW846?
Y
N
Greater than 50 mg/kg?
Y
N
(Cannot fail WET or TCLP tests)
WET
Waste Extraction Test Less than 5 mg/l?
Y
(Typically cannot fail TCLP test)
N
TCLP
Toxicity Characteristic Leaching Procedure. Compare result to Soluble Threshold Limit Concentration Federal Test for Leachable Metals Less than 5mg/l?
Y
N
Dispose of as non-hazardous waste (Class III)
Dispose of as Class I Hazardous waste, Stabilization not required. (non-RCRA California Hazardous Waste)
Dispose of as Class I Hazardous Waste, Stabilization is Required (RCRA Hazardous Waste)

Test Type		Standard
SW846	California test for total lead concentration	Total Threshold Limit Concentration (TTLC) 1000 mg/kg
WET	Waste Extraction Test - CALIF test for leachable lead	Soluble Threshold Limit Concentration (STLC): 5 mg/l
TCLP	Toxicity Characteristic Leaching Procedure. Federal test for leachability of lead	Soluble Threshold Limit Concentration (STLC): 5 mg/l

Disposal Options:

- **Class I** - Hazardous:
  - Non-RCRA (California Hazardous) if Total Lead >1,000 mg/kg or WET >5 mg/l & TCLP <5 mg/l
  - RCRA if TCLP >5 mg/l (requires stabilization)
- **Class II** - Non-Hazardous w/ WET≥1.5 mg/l but <5 mg/l
- **Class III** - Non-Hazardous, including Intact Painted Architectural Components, or
  - Non-Designated Waste w/ STLC <1.5 mg/l

Source: BDC Services, Inc.

©SCA Environmental, Inc.

11.6 Standards for Lead in Soil

As required by the HUD Guidelines, typical clearance criteria for soils include the following:

Area	Standard
Play Areas and High Contact Areas for Children	400 µg/g
Building Perimeter (Drip Line) and Yard	2,000 µg/g
Paving or Removal Criteria	5,000 µg/g

In reporting results, use the most conservative applicable standard. For example, if the area near the building drip line is used as a children's play area, use the lower, 400 µg/g standard.

11.7 HUD Wipe Clearance Criteria

Wipe tests will be used to test surface concentrations for lead dust as required by the Technical Specifications or the HUD Guidelines. Typical HUD clearance criteria include:

Area/Method	Standard
Floor Wipe Samples	100 µg/SF
Window Sills Wipe Samples	500 µg/SF
Window Wells Wipe Samples	800 µg/SF

11.8 Standard for Lead in Drinking Water

Lead in Water	EPA[1]	15 ppb or 0.015 mg/liter	Recommended Action Level (To be used as criteria for drinking water contamination for surveys)	Maximum Contaminant Level Goal (MCLG) for lead; Level associated with no adverse health effects.
	DOHS[2]	50 ppb or 0.05 mg/liter	Enforceable Standard	Maximum Contaminant Limit (MCL) for lead; this is the enforceable standard

1 Environmental Protection Agency, The Safe Drinking Water Act, 40 CFR Part 141.80.

2 California Department of Health Services, Title 26 California Code of Regulations (CCR) per EPA test method 6010A.

The EPA's standard of 15 ppb was developed as a standard for evaluating the lead safety performance of large water utilities, and is used here as an action standard.

11.9 Standards for Airborne Lead

Lead in Air	EPA[1]	1.5 $\mu g/m^3$	Ambient Air	EPA quarterly calendar average background level for airborne lead
	OSHA[2]	30 $\mu g/m^3$	Enforceable Standard	OSHA action level for occupational exposure to airborne lead
	OSHA[2]	50 $\mu g/m^3$	Enforceable Standard	OSHA Permissible Exposure Level for airborne lead

[1] USEPA National Ambient Air Quality Standard (NAAQS)
[2] Division of Industrial Safety, Article 110, Section 5216

Appendix A: XRF Performance Characteristic Sheets

XRF PERFORMANCE CHARACTERISTICS SHEET
Radiation Monitoring Devices; LPA-1

EFFECTIVE DATE: November 27, 1995 **EDITION NO.** 1

MANUFACTURER AND MODEL:

Make:	*Radiation Monitoring Devices*
Model:	*LPA-1*
Source:	Co^{57}
Note:	This sheet supersedes all previous sheets for the XRF instrument of the make, model, and source shown above.

EVALUATION DATA SOURCE AND DATE.

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated from the EPA/HUD evaluation using archived building components. Testing was conducted on approximately 150 test locations. All of the test locations were tested three times, once in March 1995, once in July 1995, and once in September 1995 using three distinct instruments. The instrument that performed testing in March had a new source installed in January 1995 with 12 mCi initial strength. The instrument that performed testing in July had a new source installed in June 1995 with 12 mCi initial strength. The instrument that performed testing in September had a new source installed in February 1995 with 12 mCi initial strength. LPA-1 instruments that were purchased before June 26, 1995 and have not been serviced since June 26, 1995 have a different version of firmware than those instruments sold or serviced after June 26, 1995. Therefore, this sheet distinguishes between instruments sold prior to June 26, 1995 and have not been serviced since June 26, 1995 from those instruments serviced or sold after this date.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS:

Performance parameters shown in this sheet are applicable only when operating the instrument under the same conditions as the evaluation testing and using the procedures described in Chapter 7 of the HUD Guidelines. Operating parameters include:

- Manufacturer-recommended warm-up and quality control procedures
- Use the Multifamily Decision Flowchart for determining the presence of lead on a component type in multifamily housing
- Quick mode, nominal 20-second standard mode, or nominal 30-second standard mode readings on three locations per component for single-family housing and one location per component for multifamily housing
- The nominal reading time for standard mode readings must be adjusted to account for source decay
- Calibration checks are taken using nominal 30-second standard mode readings and the red (1.02 mg/cm^2) NIST Standard Reference Material (SRM No. 2579) paint film

XRF PERFORMANCE CHARACTERISTICS SHEET
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- Readings for determining the substrate correction values are taken on bare substrate covered with red (1.02 mg/cm^2) NIST SRM paint film

- Lead-based paint is defined as paint with lead equal to or in excess of 1.0 mg/cm^2.

XRF CALIBRATION CHECK:

Chapter 7 of the HUD Guidelines recommends using a calibration check procedure to determine the operating condition of the XRF instrument. For this instrument, calibration check readings should be taken with nominal 30-second standard mode readings regardless of the date of purchase or servicing. If the observed calibration check average minus 1.02 mg/cm^2 is greater than the positive (plus) calibration check tolerance value, or less than the negative (minus) calibration check tolerance value then the instructions provided by the manufacturer should be followed in order to bring the instrument back into control before any more XRF testing is done. This calibration check is estimated to produce an incorrect result (that is, a finding that the instrument is out of calibration) very infrequently - once out of every 200 times this procedure is followed.

For those instruments sold prior to June 26, 1995 and have not been serviced since June 26, 1995 use the following calibration check tolerance values.

minus value = -0.3 mg/cm^2
plus value = +0.1 mg/cm^2

For those instruments sold or serviced after June 26, 1995 use the following calibration check tolerance values:

minus value = -0.3 mg/cm^2
plus value = +0.3 mg/cm^2

XRF RESULTS BELOW 4.0 mg/cm^2, SUBSTRATE CORRECTION RECOMMENDED FOR:

For those instruments sold prior to June 26, 1995 and have not been serviced since June 26, 1995

- Metal and wood using quick mode or either 20-second or 30-second standard mode readings

For those instruments sold or serviced after June 26, 1995:

- Metal using 30-second standard mode readings
- None using quick mode readings

XRF PERFORMANCE CHARACTERISTICS SHEET
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SUBSTRATE CORRECTION NOT RECOMMENDED FOR:

For those instruments sold prior to June 26, 1995 and have not been serviced since June 26, 1995:

- Brick, Concrete, Drywall, and Plaster using quick mode or either 20-second or 30-second standard mode readings

For those instruments sold or serviced after June 26, 1995:

- Brick, Concrete, Drywall, Plaster, and Wood using 30-second standard mode readings
- Brick, Concrete, Drywall, Metal, Plaster, and Wood using quick mode readings

SUBSTRATE CORRECTION VALUE COMPUTATION:

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bias. Supplemental guidance for using the red (1.02 mg/cm^2) NIST SRM paint film for substrate correction is provided below.

XRF results are corrected for substrate bias by subtracting from each XRF result a correction value determined separately in each house for single-family housing or in each development for multifamily housing, for each substrate. The correction value is an average of XRF readings taken over red NIST SRM (1.02 mg/cm^2) paint films at test locations that had been scraped clean of their paint covering. Compute the correction values as follows:

- Using the same XRF instrument, take three readings on a bare substrate area covered with the red NIST SRM (1.02 mg/cm^2) paint film. Repeat this procedure by taking three more readings on a second bare substrate area of the same substrate.

- Compute the correction value for each substrate type by computing the average of all six readings as shown below.

For each substrate type:

$$\left.\begin{matrix}\text{Correction}\\ \text{Value}\end{matrix}\right\} = \frac{1^{st} + 2^{nd} + 3^{rd} + 4^{th} + 5^{th} + 6^{th}\ \text{Reading}}{6} - 1.02 \text{mg/cm}^2$$

- Repeat this procedure for each substrate tested in the house or housing development as needed.

XRF PERFORMANCE CHARACTERISTICS SHEET
Radiation Monitoring Devices; LPA-1

CLASSIFICATION OF RESULTS USING THRESHOLD VALUES:

XRF results are classified using either the threshold or the inconclusive range. In single-family housing, an XRF result is the average of three readings taken on a testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). In multifamily housing, an XRF result is a single reading taken on a testing combination. For computing the XRF result, use all digits that are reported by the instrument. For the threshold, results are classified as positive if they are greater than or equal to the threshold, and negative if they are less than the threshold. There is no inconclusive classification when using the threshold. For the inconclusive range, results are classified as positive if they are greater than or equal to the upper limit of the inconclusive range, and negative if they are less than or equal to the lower limit of the inconclusive range. Thresholds and inconclusive ranges were determined for comparing results to the 1.0 mg/cm^2 standard. For a listing of laboratories recommended by the EPA National Lead Laboratory Accreditation Program (NLLAP) for the analysis of samples to resolve an inconclusive XRF result or additional confirmational analysis, call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

For those instruments sold prior to June 26, 1995 and have not been serviced since June 26, 1995.

30-SECOND STANDARD MODE READING DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)
Results corrected for substrate bias on metal and wood substrates only	Brick	0.8
	Concrete	0.6
	Drywall	0.7
	Metal	0.8
	Plaster	0.8
	Wood	0.9

For those instruments sold prior to June 26, 1995 and have not been serviced since June 26, 1995:

20-SECOND STANDARD MODE READING DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)
Results corrected for substrate bias on metal and wood substrates only	Brick	0.7
	Concrete	0.7
	Drywall	0.7
	Metal	0.9
	Plaster	0.8
	Wood	0.8

XRF PERFORMANCE CHARACTERISTICS SHEET
Radiation Monitoring Devices; LPA-1

For those instruments sold prior to June 26, 1995 and have not been serviced since June 26, 1995:

QUICK MODE READING DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE (mg/cm^2)
Results corrected for substrate bias on metal and wood substrates only	Brick	0.7 - 0.8
	Concrete	0.7 - 0.8
	Drywall	0.6 - 0.8
	Metal	0.9 - 1.0
	Plaster	0.7 - 0.8
	Wood	0.7 - 0.9

For those instruments sold or serviced after June 26, 1995:

30-SECOND STANDARD MODE READING DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)
Results corrected for substrate bias on metal substrate only	Brick	1.0
	Concrete	1.0
	Drywall	1.0
	Metal	0.9
	Plaster	1.0
	Wood	1.0

For those instruments sold or serviced after June 26, 1995:

QUICK MORE READING DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)	INCONCLUSIVE RANGE (mg/cm^2)
Readings not corrected for substrate bias on any substrate	Brick	1.0	None
	Concrete	1.0	None
	Drywall	1.0	None
	Metal	None	0.9 to 1.3
	Plaster	None	0.9 to 1.0
	Wood	1.0	None

INSTRUCTIONS FOR EVALUATING XRF TESTING:

Chapter 7 of the HUD Guidelines recommends several options for evaluating XRF testing. Among those options is the following procedure which may be used after XRF testing has been completed. In single-family housing, an XRF result is the average of three readings taken on a testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). In multifamily housing, an XRF result is a single reading taken on a testing combination. If a multifamily

housing development is being retested, randomly select two units from within the development from which the ten testing combinations should be randomly selected.

Randomly select ten testing combinations for retesting from each house or from the two selected units.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family housing a result is defined as the average of three readings. In multifamily housing, a result is a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Compute the square of each of the ten original and ten retest XRF results.

Add these squares of XRF results together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the overall average of all ten original XRF results over all ten testing combinations selected for retesting.

Compute the overall average of all ten retest XRF results over all ten testing combinations selected for retesting.

Take the difference of the overall average of the ten original XRF results and the overall average of the ten retest XRF results. If the difference is negative, drop the negative sign.

If the difference of the overall averages is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

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BIAS AND PRECISION:

Do not use these bias and precision data to correct for substrate bias. These bias and precision data were computed without substrate correction from samples with reported laboratory results less than 4.0 mg/cm^2 lead. The data which were used to determine the bias and precision estimates given in the three tables above have the following properties. During the March testing, there were 11 test locations with a laboratory reported result equal to or greater than 4.0 mg/cm^2 lead. Of these, one 20-second standard mode reading was less than 1.0 mg/cm^2 and none of the quick mode readings were less than 1.0 mg/cm^2. During the July testing, there were 15 test locations with a laboratory reported result equal to or greater than 4.0 mg/cm^2 lead. Of these, one 30-second standard mode reading was less than 1.0 mg/cm^2 and none of the quick mode readings were less than 1.0 mg/cm^2. During the September testing, there were 15 test locations with a laboratory reported result equal to or greater than 4.0 mg/cm^2 lead. Of these, two 20-second and one 30-second standard mode readings were less than 1.0 mg/cm^2, and one quick mode reading was less than 1.0 mg/cm^2. The two instruments that tested in March and September are representative of instruments sold prior to June 26, 1995 and have not been serviced since June 26, 1995 and the instrument that tested in July is representative of instruments sold or serviced after June 26, 1995. These data are for illustrative purposes only. Actual bias must be determined on the site. Inconclusive ranges provided above already account for bias and precision. Bias and precision ranges are provided to show the variability that was found between machines of the same model. Units are in mg/cm^2

XRF PERFORMANCE CHARACTERISTICS SHEET
Radiation Monitoring Devices; LPA-1

For those instruments sold prior to June 26, 1995 and have not been serviced since June 26, 1995:

20-SECOND READING MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	BIAS RANGE* (mg/cm^2)	PRECISION* (mg/cm^2)	PRECISION RANGE* (mg/cm^2)
0.0 mg/cm^2	Brick	-0.2	(-0.1,-0.2)	0.2	(0.1, 0.2)
	Concrete	-0.2	(-0.1,-0.2)	0.2	(0.1, 0.2)
	Drywall	-0.2	(-0.2,-0.3)	0.2	(0.1, 0.2)
	Metal	-0.4	(-0.4,-0.5)	0.2	(0.1, 0.2)
	Plaster	-0.1	(-0.1,-0.1)	0.2	(0.1, 0.2)
	Wood	-0.2	(-0.1,-0.2)	0.2	(0.1, 0.2)
0.5 mg/cm^2	Brick	-0.2	(-0.2,-0.3)	0.3	(0.2, 0.3)
	Concrete	-0.2	(-0.2,-0.3)	0.3	(0.2, 0.3)
	Drywall	-0.3	(-0.2,-0.3)	0.3	(0.2, 0.3)
	Metal	-0.5	(-0.4,-0.6)	0.3	(0.2, 0.3)
	Plaster	-0.2	(-0.2,-0.2)	0.3	(0.2, 0.3)
	Wood	-0.2	(-0.2,-0.3)	0.3	(0.2, 0.3)
1.0 mg/cm^2	Brick	-0.3	(-0.2,-0.4)	0.3	(0.3, 0.4)
	Concrete	-0.3	(-0.2,-0.4)	0.3	(0.3, 0.4)
	Drywall	-0.3	(-0.2,-0.4)	0.3	(0.3, 0.4)
	Metal	-0.6	(-0.5,-0.6)	0.3	(0.3, 0.4)
	Plaster	-0.2	(-0.2,-0.2)	0.3	(0.3, 0.4)
	Wood	-0.3	(-0.2,-0.4)	0.3	(0.3, 0.4)
2.0 mg/cm^2	Brick	-0.4	(-0.3,-0.5)	0.5	(0.4, 0.5)
	Concrete	-0.4	(-0.3,-0.5)	0.5	(0.4, 0.5)
	Drywall	-0.5	(-0.4,-0.6)	0.5	(0.4, 0.5)
	Metal	-0.7	(-0.6,-0.7)	0.5	(0.4, 0.5)
	Plaster	-0.3	(-0.3,-0.4)	0.5	(0.4, 0.5)
	Wood	-0.4	(-0.3,-0.5)	0.5	(0.4, 0.5)

*Ranges are provided to show the variability between machines of the same model.
*Precision at 1 standard deviation.

XRF PERFORMANCE CHARACTERISTICS SHEET
Radiation Monitoring Devices; LPA-1

For those instruments sold prior to June 26, 1995 and have not been serviced since June 26, 1995:

30-SECOND READING MEASURED AT	SUBSTRATE	BIAS (mg/cm²)	PRECISION* (mg/cm²)
0.0 mg/cm²	Brick	-0.1	0.1
	Concrete	-0.1	0.1
	Drywall	-0.2	0.1
	Metal	-0.4	0.1
	Plaster	-0.1	0.1
	Wood	-0.1	0.1
0.5 mg/cm²	Brick	-0.2	0.2
	Concrete	-0.2	0.2
	Drywall	-0.3	0.2
	Metal	-0.5	0.2
	Plaster	-0.1	0.2
	Wood	-0.2	0.2
1.0 mg/cm²	Brick	-0.2	0.3
	Concrete	-0.2	0.3
	Drywall	-0.3	0.3
	Metal	-0.6	0.3
	Plaster	-0.2	0.3
	Wood	-0.2	0.3
2.0 mg/cm²	Brick	-0.4	0.4
	Concrete	-0.4	0.4
	Drywall	-0.5	0.4
	Metal	-0.7	0.4
	Plaster	-0.3	0.4
	Wood	-0.4	0.4

*Precision at 1 standard deviation.

XRF PERFORMANCE CHARACTERISTICS SHEET
Radiation Monitoring Devices; LPA-1

For those instruments sold prior to June 26, 1995 and have not been serviced since June 26, 1995:

QUICK MODE MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	BIAS RANGE+ (mg/cm^2)	PRECISION* (mg/cm^2)	PRECISION RANGE* (mg/cm^2)
0.0 mg/cm^2	Brick	-0.2	(-0.2,-0.3)	0.3	(0.3, 0.3)
	Concrete	-0.2	(-0.2,-0.3)	0.3	(0.3, 0.3)
	Drywall	-0.3	(-0.2,-0.3)	0.3	(0.3, 0.3)
	Metal	-0.6	(-0.6,-0.7)	0.3	(0.3, 0.3)
	Plaster	-0.2	(-0.2,-0.2)	0.3	(0.3, 0.3)
	Wood	-0.2	(-0.2,-0.3)	0.3	(0.3, 0.3)
0.5 mg/cm^2	Brick	-0.3	(-0.2,-0.3)	0.4	(0.3, 0.4)
	Concrete	-0.3	(-0.2,-0.3)	0.4	(0.3, 0.4)
	Drywall	-0.3	(-0.2,-0.4)	0.4	(0.3, 0.4)
	Metal	-0.7	(-0.6,-0.8)	0.4	(0.3, 0.4)
	Plaster	-0.2	(-0.2,-0.2)	0.4	(0.3, 0.4)
	Wood	-0.3	(-0.2,-0.3)	0.4	(0.3, 0.4)
1.0 mg/cm^2	Brick	-0.3	(-0.3,-0.4)	0.4	(0.4, 0.5)
	Concrete	-0.3	(-0.3,-0.4)	0.4	(0.4, 0.5)
	Drywall	-0.4	(-0.3,-0.4)	0.4	(0.4, 0.5)
	Metal	-0.7	(-0.7,-0.8)	0.4	(0.4, 0.5)
	Plaster	-0.3	(-0.3,-0.3)	0.4	(0.4, 0.5)
	Wood	-0.3	(-0.3,-0.4)	0.4	(0.4, 0.5)
2.0 mg/cm^2	Brick	-0.4	(-0.4,-0.5)	0.5	(0.4, 0.6)
	Concrete	-0.4	(-0.4,-0.5)	0.5	(0.4, 0.6)
	Drywall	-0.5	(-0.4,-0.6)	0.5	(0.4, 0.6)
	Metal	-0.8	(-0.7,-1.0)	0.5	(0.4, 0.6)
	Plaster	-0.4	(-0.4,-0.4)	0.5	(0.4, 0.6)
	Wood	-0.4	(-0.4,-0.5)	0.5	(0.4, 0.6)

+Ranges are provided to show the variability between machines of the same model.
*Precision at 1 standard deviation.

XRF PERFORMANCE CHARACTERISTICS SHEET
Radiation Monitoring Devices; LPA-1

For those instruments sold or serviced after June 26, 1995:

30-SECOND STANDARD MODE READING MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	PRECISION* (mg/cm^2)
0.0 mg/cm^2	Brick	0.0	0.1
	Concrete	0.0	0.1
	Drywall	0.1	0.1
	Metal	0.3	0.1
	Plaster	0.1	0.1
	Wood	0.0	0.1
0.5 mg/cm^2	Brick	0.0	0.2
	Concrete	0.0	0.2
	Drywall	0.0	0.2
	Metal	0.2	0.2
	Plaster	0.0	0.2
	Wood	0.0	0.2
1.0 mg/cm^2	Brick	0.0	0.3
	Concrete	0.0	0.3
	Drywall	0.0	0.3
	Metal	0.2	0.3
	Plaster	0.0	0.3
	Wood	0.0	0.3
2.0 mg/cm^2	Brick	-0.1	0.4
	Concrete	-0.1	0.4
	Drywall	-0.1	0.4
	Metal	0.1	0.4
	Plaster	-0.1	0.4
	Wood	-0.1	0.4

*Precision at 1 standard deviation.

XRF PERFORMANCE CHARACTERISTICS SHEET
Radiation Monitoring Devices: LPA-1

For those instruments sold or serviced after June 26, 1995:

QUICK MODE READING MEASURED AT	SUBSTRATE	BIAS (mg/cm²)	PRECISION (mg/cm²)
0.0 mg/cm²	Brick	0.0	0.2
	Concrete	0.0	0.2
	Drywall	0.0	0.2
	Metal	0.2	0.2
	Plaster	0.0	0.2
	Wood	0.0	0.2
0.5 mg/cm²	Brick	0.0	0.3
	Concrete	0.0	0.3
	Drywall	0.0	0.3
	Metal	0.2	0.3
	Plaster	0.0	0.3
	Wood	0.0	0.3
1.0 mg/cm²	Brick	0.0	0.4
	Concrete	0.0	0.4
	Drywall	0.0	0.4
	Metal	0.1	0.4
	Plaster	-0.1	0.4
	Wood	0.0	0.4
2.0 mg/cm²	Brick	-0.1	0.5
	Concrete	-0.1	0.5
	Drywall	-0.1	0.5
	Metal	0.1	0.5
	Plaster	-0.1	0.5
	Wood	-0.1	0.5

*Precision at 1 standard deviation.

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristic Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7 of the *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead-Based Paint Abatement and Poisoning Prevention, U.S. Department of Housing and Urban Development, Room B-133, 451 Seventh St. S.W., Washington, DC 20410.

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XRF PERFORMANCE CHARACTERISTICS SHEET
Warrington, Inc.; Microlead I revision 4

EFFECTIVE DATE: September 25, 1995 **EDITION NO.:** 1

MANUFACTURER AND MODEL:

Make:	*Warrington, Inc.*
Model:	*Microlead I revision 4*
Source:	Co^{57}
Note:	This sheet supersedes all previous sheets for the XRF instrument of the make, model, and source shown above

EVALUATION DATA SOURCE AND DATE:

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated from evaluation data collected during the EPA/HUD field evaluation study conducted from March through October 1993. The data were collected from approximately 1,200 test locations using five instruments with source dates ranging from March 1993 to October 1993. All five instruments had sources with 10 mCi initial strengths. The results of this study are reported in *A Field Test of Lead-Based Paint Testing Technologies: Technical Report*, EPA 747-R-95-002b, May 1995.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS:

Performance parameters shown in this sheet are applicable only when operating the instrument under the same conditions as the evaluation testing and using the procedures described in Chapter 7 of the HUD Guidelines. Operating parameters include:

- Manufacturer-recommended warm-up and quality control procedures
- Use the Multifamily Decision Flowchart for determining the presence of lead on a component type in multifamily housing
- Nominal 15-second readings on three locations per component for single-family housing and one location per component for multifamily housing
- Calibration checks are taken using the red (1.02 mg/cm^2) NIST Standard Reference Material (SRM No. 2579) paint film
- Readings for determining the substrate correction values are taken on bare substrate covered with red (1.02 mg/cm^2) NIST SRM paint film
- Lead-based paint is defined as paint with lead equal to or in excess of 1.0 mg/cm^2

XRF PERFORMANCE CHARACTERISTICS SHEET
Warrington, Inc.; Microlead I revision 4

XRF CALIBRATION CHECK:

Chapter 7 of the HUD Guidelines recommends using a calibration check procedure to deter the operating condition of the XRF instrument. If the observed calibration check average minus mg/cm^2 is greater than the positive (plus) calibration check tolerance value, or less than the nega (minus) calibration check tolerance value, then the instructions provided by the manufacturer shoul followed in order to bring the instrument back into control before any more XRF testing is done. calibration check is estimated to produce an incorrect result (that is, a finding that the instrument is ou of calibration) very infrequently - once out of every 200 times this procedure is followed.

minus value = -0.6 mg/cm^2
plus value = +0.6 mg/cm^2

FOR XRF RESULTS BELOW 4.0 mg/cm^2, SUBSTRATE CORRECTION RECOMMENDED FOR:

Brick, Concrete, Drywall, Metal, and Wood.

SUBSTRATE CORRECTION <u>NOT</u> RECOMMENDED FOR:

Plaster.

SUBSTRATE CORRECTION VALUE COMPUTATION:

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bi Supplemental guidance for using the red (1.02 mg/cm^2) NIST SRM paint film for substrate correctio provided below.

XRF results are corrected for substrate bias by subtracting from each XRF result a correction v determined separately in each house for single-family housing or in each development for multifa housing, for each substrate. The correction value is an average of XRF readings taken over red NI SRM (1.02 mg/cm^2) paint films at test locations that had been scraped clean of their paint cover Compute the correction values as follows:

- Using the same XRF instrument, take three readings on a <u>bare</u> substrate area covered with re red NIST SRM (1.02 mg/cm^2) paint film. Repeat this procedure by taking three more readings a second <u>bare</u> substrate area of the same substrate covered with the red NIST SRM (1 mg/cm^2) paint film.

- Compute the correction value for each substrate type by computing the average of all six readi as shown below.

XRF PERFORMANCE CHARACTERISTICS SHEET
Warrington, Inc.; Microlead I revision 4

For each substrate type:

$$\left.\begin{matrix}\textit{Correction}\\ \textit{Value}\end{matrix}\right\} = \frac{1^{st} + 2^{nd} + 3^{rd} + 4^{th} + 5^{th} + 6^{th}\ \textit{Reading}}{6} - 1.02 mg/cm^2$$

- Repeat this procedure for each substrate tested in the house or housing development.

INCONCLUSIVE RANGE:

XRF results are classified as positive if they are greater than or equal to the upper limit of the inconclusive range, and negative if they are less than or equal to the lower limit of the inconclusive range. In single-family housing, an XRF result is the average of three readings taken on a testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). In multifamily housing, an XRF result is a single reading taken on a testing combination. For computing the XRF result, use all digits that are reported by the instrument. Inconclusive ranges were determined for comparing results to the 1.0 mg/cm^2 standard. For a listing of laboratories recommended by the EPA National Lead Laboratory Accreditation Program (NLLAP) for the analysis of samples to resolve an inconclusive XRF result or additional confirmational analysis, call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE in mg/cm^2
Results corrected for substrate bias on all substrates except plaster	Brick	0.8 to 1.3
	Concrete	0.5 to 1.4
	Drywall	0.9 to 1.1
	Metal	0.9 to 1.4
	Plaster	0.7 to 1.6
	Wood	0.9 to 1.6

INSTRUCTIONS FOR EVALUATING XRF TESTING:

Chapter 7 of the *HUD Guidelines* recommends several options for evaluating XRF testing. Among those options is the following procedure which may be used after XRF testing has been completed. In single-family housing, an XRF result is the average of three readings taken on a testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). In multifamily housing, an XRF result is a single reading taken on a testing combination. If a multifamily housing development is being retested, randomly select two units from within the development from which the ten testing combinations should be randomly selected.

Randomly select ten testing combinations for retesting from each house or from the two selected units.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family housing a result is defined as the average of three readings. In multifamily housing, a result is a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Compute the square of each of the ten original and ten retest XRF results.

Add these squares of XRF results together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the overall average of all ten original XRF results over all ten testing combinations selected for retesting.

Compute the overall average of all ten retest XRF results over all ten testing combinations selected for retesting.

Take the difference of the overall average of the ten original XRF results and the overall average of the ten retest XRF results. If the difference is negative, drop the negative sign.

If the difference of the overall averages is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted approximately 1 out of 100 dwelling units tested.

- An INCONCLUSIVE classification is obtained if at least two of the three individual L-readings are classified as inconclusive or if one L-reading is classified as positive, another is classified as negative, and the third is classified as inconclusive.

G. Resolution of results classified as inconclusive.

Any results classified as inconclusive require further investigation in the same manner as described above for multifamily housing with one exception. Take three 120-second nominal K-readings instead of a single one. Obtain a classification by combining the individual results of the three K-readings. Resolve the inconclusive classification by classifying the combined K-shell readings or with laboratory analysis as described below.

- A POSITIVE classification is obtained if at least two of the three individual K-readings where classified as positive.
- A NEGATIVE classification is obtained if at least two of the three individual K-readings where classified as negative.
- An INCONCLUSIVE classification is obtained if at least two of the three individual K-readings where classified as inconclusive.
- To resolve a remaining INCONCLUSIVE classification, remove a paint-chip sample and have it analyzed in a laboratory as described in Chapter 7 of the HUD Guidelines.

INSTRUCTIONS FOR EVALUATING XRF TESTING:

Chapter 7 of the HUD Guidelines recommends several options for evaluating XRF testing. Among those options is the following procedure which may be used after XRF testing has been completed. In single-family housing, an XRF result is the average of three readings taken on a testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines) In multifamily housing, an XRF result is a single reading taken on a testing combination. If a multifamily housing development is being retested, randomly select two units from within the development from which the ten testing combinations should be randomly selected.

Randomly select ten testing combinations for retesting from each house or from the two selected units

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below

Use the 20-second L-shell readings, ignoring the ">" and ">>" symbols that precede the displayed readings if they occur.

Compute the Retest Tolerance Limit by the following steps:

- Classify the L-reading as INCONCLUSIVE if the numerical result that follows the greater than symbol is less than 1.0.

If the numerical L-reading is displayed alone (that is, without any preceding greater-than symbols) then:

- Classify the L-reading as POSITIVE if the numerical result is equal to or greater than 1.0.
- Classify the L-reading as NEGATIVE if the numerical result is less than 1.0.

C. Resolution of results classified as inconclusive.

All results classified as inconclusive above require further investigation. Take a 120-second nominal XRF reading and use the K-shell reading. In multifamily housing, resolve the inconclusive classification with a single K-shell reading or laboratory analysis as described below.

- Classify the result as POSITIVE if either the K-reading minus the displayed precision value or the lower K-reading is equal to or greater than 1.0.
- Classify the result as NEGATIVE if either the K-reading plus the displayed precision value or the upper K-reading is less than 1.0.
- Classify the result as INCONCLUSIVE if neither of the above decision rules using the K-reading provided a classification which can occur when the upper K-reading is equal to or greater than 1.0 or the lower K-reading is less than 1.0.
- To resolve a remaining INCONCLUSIVE classification, remove a paint-chip sample and have it analyzed in a laboratory as described in Chapter 7 of the HUD Guidelines.

SINGLE-FAMILY HOUSING XRF RESULT CLASSIFICATIONS:

D. Take three 20-second nominal readings on each testing combination.

E. Classify each L-reading using the methodology described in item A under Multifamily Housing XRF Result Classifications.

F. Classification of the XRF result for a given testing combination is obtained by combining the individual results of the three L-shell readings as follows:

- A POSITIVE classification is obtained if at least two of the three individual L-readings are classified as positive.
- A NEGATIVE classification is obtained if at least two of the three individual L-readings are classified as negative.

XRF PERFORMANCE CHARACTERISTICS SHEET
Niton Corporation; XL-309 Spectrum Analyzer

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family housing a result is defined as the average of three readings. In multifamily housing, a result is a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Compute the square of each of the ten original and ten retest XRF results.

Add these squares of XRF results together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the overall average of all ten original XRF results over all ten testing combinations selected for retesting.

Compute the overall average of all ten retest XRF results over all ten testing combinations selected for retesting.

Take the difference of the overall average of the ten original XRF results and the overall average of the ten retest XRF results. If the difference is negative, drop the negative sign.

If the difference of the overall averages is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

XRF PERFORMANCE CHARACTERISTICS SHEET
Niton Corporation; XL-309 Spectrum Analyzer

BIAS AND PRECISION:

These bias and precision data were computed without substrate correction using the using 20-se L-shell readings from samples with reported laboratory results less than 4.0 mg/cm^2 lead. Rea reported by the instrument in the ">*x*" or ">>*x*" format were not used in the computation. There we test locations with a laboratory reported result equal to or greater than 4.0 mg/cm^2 lead. Of thes readings were reported in the ">*x*" or ">>*x*" format, but of the 3 remaining, 1 had an XRF reading less 1.0 mg/cm^2. These data are for illustrative purposes only. Substrate correction is not recommende this XRF instrument. Units are in mg/cm^2.

MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	PRECISION* (mg/cm^2)
0.0 mg/cm^2	All	0.0	<0.1
0.5 mg/cm^2	All	0.0	0.2
1.0 mg/cm^2	All	0.0	0.3
2.0 mg/cm^2	All	-0.1	0.5

*Precision at 1 standard deviation

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explana of the statistical methodology used to construct the data in the sheets and provides empirical results using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a cop this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristics Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and th U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7 of the *Guidelines the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead-Based Paint Abatement an Poisoning Prevention, U.S. Department of Housing and Urban Development, Room B-133, 451 Seventh St, S.W., Washington, DC 20410.

XRF PERFORMANCE CHARACTERISTICS SHEET
Niton Corporation; XL-309 Spectrum Analyzer

EFFECTIVE DATE: August 24, 1995 **EDITION N**

MANUFACTURER AND MODEL:

Make:	*Niton Corporation*
Model:	*XL-309 Spectrum Analyzer*
Source:	Cd^{109}
Note:	This sheet supersedes all previous sheets for the XRF instrument of the make, model, source, and software versions shown above.

EVALUATION DATA SOURCE AND DATE:

This sheet is supplemental information to be used in conjunction with Chapter 7 of the U *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelin Performance parameters shown on this sheet are calculated from the EPA/HUD evaluation using arc building components. Testing was conducted March 1995 on approximately 150 test locations us g single instrument with an October 1994 source at 10 mCi initial strength while running software ve 1.2C. These results supersede the 1993 testing of XL prototypes reported in the document titled: *A Test of Lead-Based Paint Testing Technologies*.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS:

Performance parameters shown in this sheet are applicable only when operating the instru under the same conditions as the evaluation testing and using the procedures described in Chapter the HUD Guidelines. Operating parameters include:

- Manufacturer-recommended warm-up and quality control procedures
- Use the Multifamily Decision Flowchart for determining the presence of lead on a component type in multifamily housing
- Nominal 20-second readings for L-shell results or 120-second readings for K-shell results on three locations per component for single-family housing and one location per component for multifamily housing
- Calibration checks are taken using the red (1.02 mg/cm^2) NIST Standard Reference Material (SRM No. 2579) paint film
- Lead-based paint is defined as paint with lead equal to or in excess of 1.0 mg/cm^2.

XRF PERFORMANCE CHARACTERISTICS SHEET
Niton Corporation; XL-309 Spectrum Analyzer

XRF CALIBRATION CHECK:

Chapter 7 of the HUD Guidelines recommends using a calibration check procedure to determine the operating condition of the XRF instrument. If the observed calibration check average minus 1.02 mg/cm^2 is greater than the positive (plus) calibration check tolerance value, or less than the negative (minus) calibration check tolerance value, then the instructions provided by the manufacturer should be followed in order to bring the instrument back into control before any more XRF testing is done. This calibration check is estimated to produce an incorrect result (that is, a finding that the instrument is out of calibration) very infrequently - once out of every 200 times this procedure is followed.

minus value = -0.1 mg/cm^2
plus value = +0.1 mg/cm^2

FOR XRF RESULTS BELOW 4.0 mg/cm^2, SUBSTRATE CORRECTION RECOMMENDED FOR:

None

SUBSTRATE CORRECTION NOT RECOMMENDED FOR:

Brick, Concrete, Drywall, Metal, Plaster, and Wood

HOW TO CLASSIFY READINGS:

This section describes how to apply the readings and other information displayed by this instrument to determine the presence or absence of lead in paint using the procedures recommended in Chapter 7 of the HUD Guidelines. These guidelines recommend classifying XRF results as positive, negative, or inconclusive compared to the 1.0 mg/cm^2 standard. But because this instrument displays readings and ancillary information useful for classification purposes, an algorithmic procedure is described that makes use of not only the XRF reading but some of the other displayed information as well.

As detailed below, the algorithm for classifying results is first applied to 20-second nominal L-shell readings followed by 120-second nominal K-shell readings to resolve inconclusive results and laboratory analysis of paint-chip samples, if necessary. For a listing of laboratories recommended by the EPA National Lead Laboratory Accreditation Program (NLLAP) for the analysis of samples to perform additional confirmational analysis, call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

XRF results are classified using threshold values. For the XL-309, threshold values are the only values provided for classifying results. Results are classified as positive if they are greater than or equal to the threshold, and as negative if they are less than the threshold. There is no inconclusive classification when using threshold values. However, inconclusive results still may be obtained regardless of whether decisions are based on L-shell readings, K-shell readings, or both, as described below. Use all digits that are reported by the instrument. Threshold values, which were determined for comparing results to the 1.0 mg/cm^2 standard, are provided in the following table.

XRF PERFORMANCE CHARACTERISTICS SHEET
Niton Corporation; XL-309 Spectrum Analyzer

DESCRIPTION	SUBSTRATE	THRESHOLD* (mg/cm²)
Results not corrected for substrate bias	Brick	1.0
	Concrete	1.0
	Drywall	1.0
	Metal	1.0
	Plaster	1.0
	Wood	1.0

*Application of the decision making methodology recommended in this PCS can result in inconclusive results regardless of whether decisions are based on L-shell readings, K-shell readings, or both.

This instrument displays its lead-based paint measurements as both L-shell and K-s readings based on the corresponding L-shell and K-shell X-ray fluorescence (refer to Chapter 7 of HUD Guidelines for more details). The L-shell readings (or L-readings) are displayed as a numerical re alone, or as a numerical result preceded by either one greater-than symbol (">") or preceded by greater-than symbols (">>"). The two greater-than symbols will only be displayed when the detected l level is greater than 5.0 mg/cm^2. Since the maximum lead level reported by this instrument is 5.0 mg/c lead levels greater than 5.0 mg/cm^2 are displayed as ">>5.0". Other examples of how L-readings can displayed (in mg/cm^2 units) are "0.6" and ">0.9". The numerical display alone implies that the instrum measured the lead in the paint at the displayed level using L-shell X-ray fluorescence; 0.6 mg/cm^2 in example. A number preceded by a single greater-than symbol indicates that the measurable lead deeply buried in the paint and the detected lead level is greater than the displayed value. In the examp >0.9 indicates that the instrument detected lead deeply buried in paint at a level greater than 0.9 mg/c K-shell readings (or K-readings) are displayed in one of two ways: 1) as a single K-reading plus and mi a "precision" value or 2) as an upper K-reading and lower K-reading.

The algorithm used for testing in multifamily housing differs slightly from that used in sing family housing. This is because the recommended number of readings per testing combination var between the two types of housing. (A testing combination is a location on a painted surface as defi in Chapter 7 of the HUD Guidelines). In multifamily housing, the HUD Guidelines recommend takin single XRF reading on a testing combination. In single-family housing, three XRF readings recommended on each testing combination.

MULTIFAMILY HOUSING XRF RESULT CLASSIFICATIONS:

A. Take a single 20-second nominal reading on each testing combination.

B. Classify the L-reading based on the type of information displayed.

<u>If two greater-than symbols are displayed then</u>:

- Classify the >>5.0 L-reading as POSITIVE

<u>If one greater-than symbol is displayed then</u>:

- Classify the L-reading as POSITIVE if the numerical result that follows the greater th symbol is equal to or greater than 1.0.

the ten testing combinations should be randomly selected.

Randomly select ten testing combinations for retesting from each house or from the two selected units.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and repeat XRF readings. Do not correct the original or retest results for substrate bias. In single-family housing a result is defined as the average of three readings. In multifamily housing, a result is a single reading. Therefore, there will be ten original and ten repeat XRF results for each house or for the two selected units.

Compute the square of each of the ten original and ten repeat XRF results.

Add these squares of XRF results together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the overall average of all ten original XRF results over all ten testing combinations selected for retesting.

Compute the overall average of all ten repeat XRF results over all ten testing combinations selected for retesting.

Take the difference of the overall average of the ten original XRF results and the overall average of the ten repeat XRF results. If the difference is negative, drop the negative sign.

If the difference of the overall averages is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

XRF PERFORMANCE CHARACTERISTICS SHEET
Princeton Gamma-Tech, Inc.; XK-3

BIAS AND PRECISION:

Do not use these bias and precision data to correct for substrate bias. These bias and precision d were computed without substrate correction from samples with reported laboratory results less than 4. mg/cm^2 lead. There were 143 testing locations with a laboratory reported result equal to or greater th 4.0 mg/cm^2 lead. Of these, 1 had an XRF reading less than 1.0 mg/cm^2. These data are for illustrat purposes only. Actual bias must be determined on the site. Inconclusive ranges provided above alread account for bias and precision. Bias and precision ranges are provided whenever significant variability wa found between machines of the same model. Units are in mg/cm^2.

MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	BIAS RANGES (mg/cm^2)	PRECISION* (mg/cm^2)	PRECISION RANGES (mg/cm^2)
0.0 mg/cm^2	Brick	0.9	-	0.6	-
	Concrete	1.3	(0.6, 1.9)	0.6	(0.2, 0.6)
	Drywall	-0.1	(-0.3, 0.2)	0.3	(0.2, 0.3)
	Metal	0.9	(0.5, 1.4)	0.5	(0.4, 0.5)
	Plaster	0.8	(0.4, 1.7)	0.5	(0.4, 0.5)
	Wood	0.2	(-0.1, 1.0)	0.4	(0.3, 0.5)
0.5 mg/cm^2	Brick	0.9	-	0.6	-
	Concrete	1.3	(0.7, 1.9)	0.6	(0.5, 0.7)
	Drywall	0.0	(-0.2, 0.2)	0.4	(0.3, 0.4)
	Metal	1.1	(0.7, 1.6)	0.8	(0.4, 0.9)
	Plaster	0.8	(0.2, 1.6)	0.6	(0.4, 0.8)
	Wood	0.4	(0.1, 1.1)	0.6	(0.3, 0.9)
1.0 mg/cm^2	Brick	0.9	-	0.6	-
	Concrete	1.3	(0.7, 2.0)	0.7	(0.6, 0.8)
	Drywall	0.0	(-0.1, 0.2)	0.4	(0.4, 0.5)
	Metal	1.3	(0.9, 1.7)	1.0	(0.5, 1.1)
	Plaster	0.8	(0.0, 1.6)	0.6	(0.4, 0.7)
	Wood	0.6	(0.3, 1.3)	0.7	(0.3, 1.2)
2.0 mg/cm^2	Brick	0.9	-	0.6	-
	Concrete	1.3	(0.7, 2.0)	0.8	(0.6, 0.9)
	Drywall	0.1	(0.1, 0.2)	0.6	(0.5, 0.6)
	Metal	1.7	(1.4, 2.1)	1.4	(0.6, 1.6)
	Plaster	0.7	(-0.3, 1.6)	0.7	(0.4, 0.8)
	Wood	1.0	(0.8, 1.5)	0.9	(0.3, 1.7)

*Precision at 1 standard deviation

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanat of the statistical methodology used to construct the data in the sheets and provides empirical results fr using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy c this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristic Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7 of the *Guidelines fo the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead-Based Paint Abatement and Poisoning Prevention, U.S. Department of Housing and Urban Development, Room B-133, 451 Seventh St, S.W., Washington, DC 20410.

XRF PERFORMANCE CHARACTERISTICS SHEET
Princeton Gamma-Tech, Inc.; XK-3

XRF CALIBRATION CHECK:

Chapter 7 of the HUD Guidelines recommends using a calibration check procedure to determine the operating condition of the XRF instrument. For this instrument, calibration check readings should be taken on wood. If the observed calibration check average minus 1.02 mg/cm^2 is greater than the positive (plus) calibration check tolerance value, or less than the negative (minus) calibration check tolerance value, then the instructions provided by the manufacturer should be followed in order to bring the instrument back into control before any more XRF testing is done. Testing must cease for those instruments with readings that exceed the calibration check tolerance limits in accordance with manufacturer's specifications. This calibration check is estimated to produce an incorrect result (that is, a finding that the instrument is out of calibration) very infrequently - once out of every 200 times this procedure is followed.

minus value =	-0.5 mg/cm^2
plus value =	+1.3 mg/cm^2

(Operators may choose to use the limits in the manufacturer's instruction manual for this calibration check. The rate of an incorrect result if the limits in the manufacturer's instruction manual are followed may be different from the rate of an incorrect result stated here).

FOR XRF RESULTS BELOW 4.0 mg/cm^2, SUBSTRATE CORRECTION RECOMMENDED FOR:

Brick, Concrete, Drywall, Metal, Plaster, and Wood.

SUBSTRATE CORRECTION NOT RECOMMENDED FOR:

None.

SUBSTRATE CORRECTION VALUE COMPUTATION:

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bias. Supplemental guidance for using the red (1.02 mg/cm^2) NIST SRM paint film for substrate correction is provided below.

XRF results are corrected for substrate bias by subtracting from each XRF result a correction value determined separately in each house for single-family housing or in each development for multifamily housing, for each substrate. The correction value is an average of XRF readings taken over red NIST SRM (1.02 mg/cm^2) paint films at test locations that had been scraped clean of their paint covering. Compute the correction values as follows:

- Using the same XRF instrument, take three readings on a bare substrate area covered with the red NIST SRM (1.02 mg/cm^2) paint film. Repeat this procedure by taking three more readings on a second bare substrate area of the same substrate covered with the red NIST SRM (1.02 mg/cm^2) paint film.

- Compute the correction value for each substrate type by computing the average of all six readings as shown below.

  For each substrate type:

$$\left.\begin{matrix}\text{Correction} \\ \text{Value}\end{matrix}\right\} = \frac{1^{st} + 2^{nd} + 3^{rd} + 4^{th} + 5^{th} + 6^{th}\ \text{Reading}}{6} - 1.02 mg/cm^2$$

- Repeat this procedure for each substrate tested in the house or housing development.

INCONCLUSIVE RANGE OR THRESHOLD:

XRF results are classified using either the threshold or the inconclusive range. In single-family housing, an XRF result is the average of three readings taken on a testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). multifamily housing, an XRF result is a single reading taken on a testing combination. For computing the XRF result, use all digits that are reported by the instrument. For the threshold, results are classified as positive if they are greater than or equal to the threshold, and negative if they are less than the threshold. There is no inconclusive classification when using the threshold. For the inconclusive range, results are classified as positive if they are greater than or equal to the upper limit of the inconclusive range, and negative if they are less than or equal to the lower limit of the inconclusive range. Thresholds and inconclusive ranges were determined for comparing results to the 1.0 mg/cm^2 standard. For a listing of laboratories recommended by the EPA National Lead Laboratory Accreditation Program (NLLAP) for the analysis of samples to resolve an inconclusive XRF result or additional confirmational analysis, call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)	INCONCLUSIVE RANGE (mg/cm^2)
Readings corrected for substrate bias on all substrates	Brick	None	0.9 to 1.3
	Concrete	None	0.8 to 1.7
	Drywall	1.0	None
	Metal	None	0.4 to 1.8
	Plaster	None	0.7 to 1.4
	Wood	None	0.9 to 1.4

INSTRUCTIONS FOR EVALUATING XRF TESTING:

Chapter 7 of the HUD Guidelines recommends several options for evaluating XRF testing. Among those options is the following procedure which may be used after XRF testing has been completed. In single-family housing, an XRF result is the average of three readings taken on a testing combination. A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines. In multifamily housing, an XRF result is a single reading taken on a testing combination. If a multifamily housing development is being retested, randomly select two units from within the development from which

XRF PERFORMANCE CHARACTERISTICS SHEET
TN Technologies (TN Spectrace); Pb Analyzer

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets, and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristics Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7 of the *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead-Based Paint Abatement and Poisoning Prevention, U.S. Department of Housing and Urban Development, Room B-133, 451 Seventh St. S.W. Washington, DC 20410.

XRF PERFORMANCE CHARACTERISTICS SHEET
Princeton Gamma-Tech, Inc.; XK-3

EFFECTIVE DATE: September 25, 1995 **EDITION NO.:**

MANUFACTURER AND MODEL:

Make:	*Princeton Gamma-Tech, Inc.*
Model:	*XK-3*
Source:	Co^{57}
Note:	This sheet supersedes all previous sheets for the XRF instrument of the make, model, and source shown above

EVALUATION DATA SOURCE AND DATE:

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HU *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines" Performance parameters shown on this sheet are calculated from evaluation data collected during EPA/HUD field evaluation study conducted from March through October 1993. The data were collecte from approximately 1,200 test locations using three instruments. One instrument had a March 1993 sourc and the other two instruments had April 1993 sources. All three instruments had sources with 10 m initial strengths. The results of this study are reported in *A Field Test of Lead-Based Paint Test Technologies: Technical Report*, EPA 747-R-95-002b, May 1995.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS:

Performance parameters shown in this sheet are applicable only when operating the instrume under the same conditions as the evaluation testing and using the procedures described in Chapter 7 the HUD Guidelines. Operating parameters include:

- Manufacturer-recommended warm-up and quality control procedures
- Use the Multifamily Decision Flowchart for determining the presence of lead on a component type in multifamily housing
- Nominal 15-second readings on three locations per component for single-family housing and one location per component for multifamily housing
- Calibration checks are taken using the red (1.02 mg/cm^2) NIST Standard Reference Material (SRM No. 2579) paint film
- Readings for determining the substrate correction values are taken on bare substrate covered with red (1.02 mg/cm^2) NIST SRM paint film
- Lead-based paint is defined as paint with lead equal to or in excess of 1.0 mg/cm^2.

XRF PERFORMANCE CHARACTERISTICS SHEET
TN Technologies (TN Spectrace); Pb Analyzer

INSTRUCTIONS FOR EVALUATING XRF TESTING:

Chapter 7 of the HUD Guidelines for recommends several options for evaluating XRF testing. Among those options is the following procedure which may be used after XRF testing has been completed. In single-family housing, an XRF result is the average of three readings taken on a testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). In multifamily housing, an XRF result is a single reading taken on a testing combination. If a multifamily housing development is being retested, randomly select two units from within the development from which the ten testing combinations should be randomly selected.

Randomly select ten testing combinations for retesting from each house or from the two selected units.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family housing a result is defined as the average of three readings. In multifamily housing, a result is a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Compute the square of each of the ten original and ten retest XRF results.

Add these squares of XRF results together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the overall average of all ten original XRF results over all ten testing combinations selected for retesting.

Compute the overall average of all ten retest XRF results over all ten testing combinations selected for retesting.

Take the difference of the overall average of the ten original XRF results and the overall average of the ten retest XRF results. If the difference is negative, drop the negative sign.

If the difference of the overall averages is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the

overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That results of this procedure will call for further examination when no examination is warranted approximately 1 out of 100 dwelling units tested.

BIAS AND PRECISION:

These bias and precision data were computed without substrate correction from samples with repo laboratory results less than 4.0 mg/cm^2 lead. There were 88 test locations with a laboratory reported re equal to or greater than 4.0 mg/cm^2 lead. Of these, none had XRF readings less than 1.0 mg/cm^2. The data are for illustrative purposes only. Substrate correction is not recommended for this XRF instrume Bias and precision ranges are provided to show the variability found between machines of the same mo Units are in mg/cm^2.

MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	BIAS RANGE$^+$ (mg/cm^2)	PRECISION* (mg/cm^2)	PRECISIO RANGE$^+$ (mg/cm^2)
0.0 mg/cm^2	Brick	0.0	(0.0, 0.0)	0.1	(0.1, 0.1)
	Concrete	0.0	(0.0, 0.0)	0.1	(0.1, 0.1)
	Drywall	0.0	(0.0, 0.0)	0.1	(0.1, 0.1)
	Metal	0.0	(-0.1, 0.1)	0.1	(0.1, 0.1)
	Plaster	0.0	(-0.1, 0.0)	0.1	(0.1, 0.1)
	Wood	0.0	(0.0, 0.0)	0.1	(<0.1, 0.1)
0.5 mg/cm^2	Brick	0.1	(0.0, 0.2)	0.3	(0.3, 0.3)
	Concrete	0.1	(0.0, 0.2)	0.3	(0.2, 0.3)
	Drywall	0.1	(0.0, 0.2)	0.3	(0.1, 0.3)
	Metal	0.1	(0.0, 0.3)	0.3	(0.3, 0.3)
	Plaster	0.0	(-0.1, 0.2)	0.3	(0.1, 0.3)
	Wood	0.1	(0.1, 0.2)	0.3	(0.3, 0.3)
1.0 mg/cm^2	Brick	0.2	(0.0, 0.4)	0.4	(0.4, 0.5)
	Concrete	0.2	(0.0, 0.4)	0.4	(0.3, 0.5)
	Drywall	0.2	(0.1, 0.4)	0.4	(0.2, 0.5)
	Metal	0.2	(0.0, 0.5)	0.4	(0.4, 0.5)
	Plaster	0.1	(-0.1, 0.3)	0.4	(0.1, 0.5)
	Wood	0.3	(0.1, 0.4)	0.4	(0.4, 0.5)
2.0 mg/cm^2	Brick	0.4	(0.0, 0.7)	0.6	(0.5, 0.6)
	Concrete	0.3	(0.0, 0.7)	0.5	(0.4, 0.6)
	Drywall	0.5	(0.3, 0.7)	0.5	(0.3, 0.6)
	Metal	0.4	(0.0, 0.8)	0.6	(0.5, 0.6)
	Plaster	0.2	(-0.3, 0.7)	0.5	(0.1, 0.6)
	Wood	0.5	(0.3, 0.7)	0.6	(0.5, 0.6)

$^+$Ranges are provided to show the variability between machines of the same model.
*Precision at 1 standard deviation

XRF PERFORMANCE CHARACTERISTICS SHEET
TN Technologies (TN Spectrace); Pb Analyzer

EFFECTIVE DATE: October 31, 1995 **EDITION NO.:** 1

MANUFACTURER AND MODEL:

Manufacturer:	*TN Technologies, Inc. (TN Spectrace)*
Make:	*Pb Analyzer*
Model:	*9292*
Source:	Cd^{109}
Note:	This sheet supersedes all previous sheets for the XRF instrument of the make, model, and source shown above.

EVALUATION DATA SOURCE AND DATE:

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated from evaluation data collected during the EPA/HUD field evaluation study conducted from March through October 1993 and from data collected during testing on the EPA/HUD archived building components in January 1995 and in September 1995. The field evaluation data were collected from approximately 1,200 test locations using two instruments both with radiation sources installed in April 1993. The results of this study are reported in *A Field Test of Lead-Based Paint Testing Technologies: Technical Report*, EPA 747-R-95-002b, May 1995. The archive testing data were collected from approximately 150 test locations using two instruments. The instrument that was used in January had a radiation source installed in July 1994 and the instrument that was used in September 1995 had a radiation source installed in January 1995. All of the aforementioned instruments had 30 mCi initial strengths.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS:

Performance parameters shown in this sheet are applicable only when operating the instrument under the same conditions as the evaluation testing and using the procedures described in Chapter 7 of the HUD Guidelines. Operating parameters include:

- Manufacturer-recommended warm-up and quality control procedures
- Use the Multifamily Decision Flowchart for determining the presence of lead on a component type in multifamily housing
- Nominal 15-second readings on three locations per component for single-family housing and one location per component for multifamily housing
- Calibration checks are taken using the red (1.02 mg/cm^2) NIST Standard Reference Material (SRM No. 2579) paint film
- Lead-based paint is defined as paint with lead equal to or in excess of 1 0 mg/cm^2

XRF PERFORMANCE CHARACTERISTICS SHEET
TN Technologies (TN Spectrace); Pb Analyzer

XRF CALIBRATION CHECK:

Chapter 7 of the HUD Guidelines recommends using a calibration check procedure to determine operating condition of the XRF instrument. If the observed calibration check average minus 1.02 mg/cm is greater than the positive (plus) calibration check tolerance value, or less than the negative (minus calibration check tolerance value, then the instructions provided by the manufacturer should be follow in order to bring the instrument back into control before any more XRF testing is done. This calibrati check is estimated to produce an incorrect result (that is, a finding that the instrument is out of calibration very infrequently - once out of every 200 times this procedure is followed.

minus value = -0.3 mg/cm^2
plus value = +0.4 mg/cm^2

FOR XRF RESULTS BELOW 4.0 mg/cm^2, SUBSTRATE CORRECTION RECOMMENDED FOR:

None

SUBSTRATE CORRECTION NOT RECOMMENDED FOR:

Brick, Concrete, Drywall, Metal, Plaster, and Wood

INCONCLUSIVE RANGE OR THRESHOLD:

XRF results are classified using either the threshold or the inconclusive range. In single-fam housing, an XRF result is the average of three readings taken on a testing combination. (A test combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). multifamily housing, an XRF result is a single reading taken on a testing combination. For computing th XRF result, use all digits that are reported by the instrument. For the threshold, results are classified positive if they are greater than or equal to the threshold, and negative if they are less than the thresho There is no inconclusive classification when using the threshold. For the inconclusive range, results ar classified as positive if they are greater than or equal to the upper limit of the inconclusive range, a negative if they are less than or equal to the lower limit of the inconclusive range. Thresholds a inconclusive ranges were determined for comparing results to the 1.0 mg/cm^2 standard. For a listing c laboratories recommended by the EPA National Lead Laboratory Accreditation Program (NLLAP) for th analysis of samples to resolve an inconclusive XRF result or additional confirmational analysis, call t National Lead Information Center Clearinghouse on 1-800-424-LEAD.

DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE in mg/cm^2	
		LOWER BOUND	UPPER BOUND
Results not corrected for substrate bias	Brick	0.9	1.2
	Concrete	0.9	1.2
	Drywall	0.9	1.2
	Metal	0.9	1.2
	Plaster	0.9	1.1
	Wood	0.9	1.3

XRF PERFORMANCE CHARACTERISTICS SHEET
Princeton Gamma-Tech, Inc.; XK-3

XRF CALIBRATION CHECK:

Chapter 7 of the HUD Guidelines recommends using a calibration check procedure to determine the operating condition of the XRF instrument. For this instrument, calibration check readings should be taken on wood. If the observed calibration check average minus 1.02 mg/cm^2 is greater than the positive (plus) calibration check tolerance value, or less than the negative (minus) calibration check tolerance value, then the instructions provided by the manufacturer should be followed in order to bring the instrument back into control before any more XRF testing is done. Testing must cease for those instruments with readings that exceed the calibration check tolerance limits in accordance with manufacturer's specifications. This calibration check is estimated to produce an incorrect result (that is, a finding that the instrument is out of calibration) very infrequently - once out of every 200 times this procedure is followed.

minus value =	-0.5 mg/cm^2
plus value =	+1.3 mg/cm^2

(Operators may choose to use the limits in the manufacturer's instruction manual for this calibration check. The rate of an incorrect result if the limits in the manufacturer's instruction manual are followed may be different from the rate of an incorrect result stated here).

FOR XRF RESULTS BELOW 4.0 mg/cm^2, SUBSTRATE CORRECTION RECOMMENDED FOR:

Brick, Concrete, Drywall, Metal, Plaster, and Wood.

SUBSTRATE CORRECTION NOT RECOMMENDED FOR:

None.

SUBSTRATE CORRECTION VALUE COMPUTATION:

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bias. Supplemental guidance for using the red (1.02 mg/cm^2) NIST SRM paint film for substrate correction is provided below.

XRF results are corrected for substrate bias by subtracting from each XRF result a correction value determined separately in each house for single-family housing or in each development for multifamily housing, for each substrate. The correction value is an average of XRF readings taken over red NIST SRM (1.02 mg/cm^2) paint films at test locations that had been scraped clean of their paint covering. Compute the correction values as follows:

- Using the same XRF instrument, take three readings on a bare substrate area covered with the red NIST SRM (1.02 mg/cm^2) paint film. Repeat this procedure by taking three more readings on a second bare substrate area of the same substrate covered with the red NIST SRM (1.02 mg/cm^2) paint film.

- Compute the correction value for each substrate type by computing the average of all six reading as shown below.

  For each substrate type:

$$\left.\begin{matrix}\text{Correction} \\ \text{Value}\end{matrix}\right\} = \frac{1^{st} + 2^{nd} + 3^{rd} + 4^{th} + 5^{th} + 6^{th}\ \text{Reading}}{6} - 1.02 mg/cm^2$$

- Repeat this procedure for each substrate tested in the house or housing development.

INCONCLUSIVE RANGE OR THRESHOLD:

XRF results are classified using either the threshold or the inconclusive range. In single-fami housing, an XRF result is the average of three readings taken on a testing combination. (A tes combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). multifamily housing, an XRF result is a single reading taken on a testing combination. For computing th XRF result, use all digits that are reported by the instrument. For the threshold, results are classified a positive if they are greater than or equal to the threshold, and negative if they are less than the thresh There is no inconclusive classification when using the threshold. For the inconclusive range, results a classified as positive if they are greater than or equal to the upper limit of the inconclusive range, ar negative if they are less than or equal to the lower limit of the inconclusive range. Thresholds a inconclusive ranges were determined for comparing results to the 1.0 mg/cm^2 standard. For a listing laboratories recommended by the EPA National Lead Laboratory Accreditation Program (NLLAP) for th analysis of samples to resolve an inconclusive XRF result or additional confirmational analysis, call th National Lead Information Center Clearinghouse at 1-800-424-LEAD.

DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)	INCONCLUSIVE RANGE (mg/cm^2)
Readings corrected for substrate bias on all substrates	Brick	None	0.9 to 1.3
	Concrete	None	0.8 to 1.7
	Drywall	1.0	None
	Metal	None	0.4 to 1.8
	Plaster	None	0.7 to 1.4
	Wood	None	0.9 to 1.4

INSTRUCTIONS FOR EVALUATING XRF TESTING:

Chapter 7 of the HUD Guidelines recommends several options for evaluating XRF testing. Amon those options is the following procedure which may be used after XRF testing has been completed. I single-family housing, an XRF result is the average of three readings taken on a testing combination. testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guideline In multifamily housing, an XRF result is a single reading taken on a testing combination. If a multifamil housing development is being retested, randomly select two units from within the development from wh

XRF PERFORMANCE CHARACTERISTICS SHEET
Scitec Corporation; MAP-3

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristics Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7 of the *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead-Based Paint Abatement and Poisoning Prevention, U.S. Department of Housing and Urban Development, Room B-133, 451 Seventh St, S.W., Washington, DC 20410.

XRF PERFORMANCE CHARACTERISTICS SHEET
Princeton Gamma-Tech, Inc.; XK-3

EFFECTIVE DATE: September 25, 1995 **EDITION NO.:** 1

MANUFACTURER AND MODEL:

Make:	*Princeton Gamma-Tech, Inc.*
Model:	*XK-3*
Source:	Co^{57}
Note:	This sheet supersedes all previous sheets for the XRF instrument of the make, model, and source shown above

EVALUATION DATA SOURCE AND DATE:

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HU *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated from evaluation data collected during the EPA/HUD field evaluation study conducted from March through October 1993. The data were collect from approximately 1,200 test locations using three instruments. One instrument had a March 1993 source and the other two instruments had April 1993 sources. All three instruments had sources with 10 mC initial strengths. The results of this study are reported in *A Field Test of Lead-Based Paint Testi Technologies: Technical Report*, EPA 747-R-95-002b, May 1995.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS.

Performance parameters shown in this sheet are applicable only when operating the instrumen under the same conditions as the evaluation testing and using the procedures described in Chapter 7 the HUD Guidelines. Operating parameters include:

- Manufacturer-recommended warm-up and quality control procedures
- Use the Multifamily Decision Flowchart for determining the presence of lead on a component type in multifamily housing
- Nominal 15-second readings on three locations per component for single-family housing and one location per component for multifamily housing
- Calibration checks are taken using the red (1.02 mg/cm^2) NIST Standard Reference Material (SRM No. 2579) paint film
- Readings for determining the substrate correction values are taken on bare substrate covered with red (1.02 mg/cm^2) NIST SRM paint film
- Lead-based paint is defined as paint with lead equal to or in excess of 1.0 mg/cm^2.

housing development is being retested, randomly select two units from within the development from which the ten testing combinations should be randomly selected. Use either 15-second readings or 60-second readings.

Randomly select ten testing combinations for retesting from each house or from the two selected units.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family housing a result is defined as the average of three readings. In multifamily housing, a result is a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Compute the square of each of the ten original and ten retest XRF results.

Add these squares of XRF results together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the overall average of all ten original XRF results over all ten testing combinations selected for retesting.

Compute the overall average of all ten retest XRF results over all ten testing combinations selected for retesting.

Take the difference of the overall average of the ten original XRF results and the overall average of the ten retest XRF results. If the difference is negative, drop the negative sign.

If the difference of the overall averages is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

XRF PERFORMANCE CHARACTERISTICS SHEET
Scitec Corporation; MAP-3

BIAS AND PRECISION:

Do not use these bias and precision data to correct for substrate bias. These bias and precision d were computed without substrate correction from samples with reported laboratory results less than mg/cm² lead. There were 124 15-second testing locations with a laboratory reported result equal t greater than 4.0 mg/cm² lead. Of these, none had XRF readings less than 1.0 mg/cm². For the 60-seco testing locations, 34 had laboratory reported results equal to or greater than 4.0 mg/cm² lead, with 2 those having XRF readings less than 1.0 mg/cm². These data are for illustrative purposes only. Ac bias must be determined on the site. Inconclusive ranges provided above already account for bias precision. Units are in mg/cm².

15-SECOND READING MEASURED AT	SUBSTRATE	BIAS (mg/cm²)	PRECISION* (mg/cm²
0.0 mg/cm²	Brick	-0.7	0.9
	Concrete	-0.7	0.9
	Drywall	0.0	0.4
	Metal	0.3	0.3
	Plaster	-0.7	0.8
	Wood	-0.1	0.5
0.5 mg/cm²	Brick	-0.5	1.0
	Concrete	-0.5	1.0
	Drywall	-0.1	0.4
	Metal	0.4	0.5
	Plaster	-0.6	0.8
	Wood	0.2	0.6
1.0 mg/cm²	Brick	-0.4	1.0
	Concrete	-0.4	1.0
	Drywall	-0.1	0.4
	Metal	0.5	0.6
	Plaster	-0.4	0.9
	Wood	0.4	0.7
2.0 mg/cm²	Brick	-0.1	1.2
	Concrete	-0.1	1.2
	Drywall	-0.3	0.4
	Metal	0.6	0.7
	Plaster	-0.2	0.9
	Wood	0.8	0.8

*Precision at 1 standard deviation

60-SECOND READING MEASURED AT	SUBSTRATE	BIAS (mg/cm²)	PRECISION* (mg/cm
0.0 mg/cm²	Brick	-0.8	0.7
	Concrete	-0.8	0.7
	Drywall	0.0	0.3
	Metal	0.3	0.2
	Plaster	-0.8	0.5
	Wood	-0.2	0.4
0.5 mg/cm²	Brick	-0.7	0.7
	Concrete	-0.7	0.7
	Drywall	-0.2	0.3
	Metal	0.4	0.3
	Plaster	-0.6	0.7
	Wood	0.1	0.4
1.0 mg/cm²	Brick	-0.7	0.7
	Concrete	-0.7	0.7
	Drywall	-0.4	0.3
	Metal	0.6	0.4
	Plaster	-0.5	0.8
	Wood	0.3	0.4
2.0 mg/cm²	Brick	-0.6	0.7
	Concrete	-0.6	0.7
	Drywall	-0.8	0.3
	Metal	0.9	0.5
	Plaster	-0.1	1.0
	Wood	0.8	0.4

*Precision at 1 standard deviation

XRF PERFORMANCE CHARACTERISTICS SHEET
Scitec Corporation; MAP-3

XRF CALIBRATION CHECK:

Chapter 7 of the HUD Guidelines recommends using a calibration check procedure to determine the operating condition of the XRF instrument. If the observed calibration check average minus 1.02 mg/cm^2 is greater than the positive (plus) calibration check tolerance value, or less than the negative (minus) calibration check tolerance value, then the instructions provided by the manufacturer should be followed in order to bring the instrument back into control before any more XRF testing is done. This calibration check is estimated to produce an incorrect result (that is, a finding that the instrument is out of calibration) very infrequently - once out of every 200 times this procedure is followed.

15-SECOND READINGS	60-SECOND READINGS
minus value = -0.6 mg/cm^2 plus value = +0.3 mg/cm^2	minus value = -0.4 mg/cm^2 plus value = +0.1 mg/cm^2

FOR XRF RESULTS BELOW 4.0 mg/cm^2, SUBSTRATE CORRECTION RECOMMENDED FOR:

Metal and Wood

SUBSTRATE CORRECTION NOT RECOMMENDED FOR:

Brick, Concrete, Drywall, and Plaster

SUBSTRATE CORRECTION VALUE COMPUTATION:

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bias. Supplemental guidance for using the red (1.02 mg/cm^2) NIST SRM paint film for substrate correction is provided below.

XRF results are corrected for substrate bias by subtracting from each XRF result a correction value determined separately in each house for single-family housing or in each development for multifamily housing, for each substrate. The correction value is an average of XRF readings taken over red NIST SRM (1.02 mg/cm^2) paint films at test locations that had been scraped clean of their paint covering. Compute the correction values as follows:

- Using the same XRF instrument, take three readings on a bare substrate area covered with the red NIST SRM (1.02 mg/cm^2) paint film. Repeat this procedure by taking three more readings on a second bare substrate area of the same substrate covered with the red NIST SRM (1.02 mg/cm^2) paint film.

- Compute the correction value for each substrate type by computing the average of all six readings as shown below.

For each substrate type:

$$\left.\begin{matrix}\text{Correction} \\ \text{Value}\end{matrix}\right\} = \frac{1^{st} + 2^{nd} + 3^{rd} + 4^{th} + 5^{th} + 6^{th}\ \text{Reading}}{6} - 1.02 mg/cm^2$$

- Repeat this procedure for each substrate tested in the house or housing development.

INCONCLUSIVE RANGE:

XRF results are classified as positive if they are greater than or equal to the upper limit of t inconclusive range, and negative if they are less than or equal to the lower limit of the inconclusive rang In single-family housing, an XRF result is the average of three readings taken on a testing combina (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelin In multifamily housing, an XRF result is a single reading taken on a testing combination. For computi the XRF result, use all digits that are reported by the instrument. Inconclusive ranges were determ for comparing results to the 1.0 mg/cm^2 standard. For a listing of laboratories recommended by the National Lead Laboratory Accreditation Program (NLLAP) for the analysis of samples to resolve inconclusive XRF result or additional confirmational analysis, call the National Lead Information Cen Clearinghouse at 1-800-424-LEAD.

15-SECOND READING DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE (mg/cm^2)
Results corrected for substrate bias for 15-second readings on metal and wood substrates only	Brick	0.0 to 1.5
	Concrete	0.0 to 1.5
	Drywall	0.9 to 1.0
	Metal	0.9 to 1.3
	Plaster	0.3 to 1.3
	Wood	0.9 to 1.3

60-SECOND READING DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)	INCONCLUSIVE RANGE (mg/cm^2)
Readings corrected for substrate bias for 60-second readings on metal and wood substrates only	Brick	None	0.3 to 0.9
	Concrete	None	0.3 to 0.9
	Drywall	None	0.6 to 0.8
	Metal	None	0.9 to 1.2
	Plaster	None	0.2 to 0.9
	Wood	1.0	None

INSTRUCTIONS FOR EVALUATING XRF TESTING:

Chapter 7 of the HUD Guidelines recommends several options for evaluating XRF testing. Amo those options is the following procedure which may be used after XRF testing has been completed single-family housing, an XRF result is the average of three readings taken on a testing combination. testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guideline In multifamily housing, an XRF result is a single reading taken on a testing combination. If a multifa

XRF PERFORMANCE CHARACTERISTICS SHEET
Advanced Detectors; LeadStar

For those instruments with software versions earlier than version 4.1.

FIXED MODE READINGS MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	PRECISION* (mg/cm^2)
0.0 mg/cm^2	Brick	0.1	0.1
	Concrete	0.1	0.1
	Drywall	0.0	0.1
	Metal	0.1	0.1
	Plaster	0.0	0.1
	Wood	0.0	0.1
0.5 mg/cm^2	Brick	0.2	0.2
	Concrete	0.2	0.2
	Drywall	0.1	0.2
	Metal	0.2	0.2
	Plaster	0.1	0.2
	Wood	0.1	0.2
1.0 mg/cm^2	Brick	0.3	0.3
	Concrete	0.3	0.3
	Drywall	0.1	0.3
	Metal	0.2	0.3
	Plaster	0.1	0.3
	Wood	0.1	0.3
2.0 mg/cm^2	Brick	0.4	0.5
	Concrete	0.4	0.5
	Drywall	0.3	0.5
	Metal	0.4	0.5
	Plaster	0.3	0.5
	Wood	0.3	0.5

*Precision at 1 standard deviation

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets, and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristics Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7 of the *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead-Based Paint Abatement and Poisoning Prevention, U.S. Department of Housing and Urban Development, Room B-133, 451 Seventh St. S.W., Washington, DC 20410.

XRF PERFORMANCE CHARACTERISTICS SHEET
Scitec Corporation; MAP-3

EFFECTIVE DATE: August 24, 1995 **EDITION NO**

MANUFACTURER AND MODEL:

Make:	*Scitec Corporation*
Model:	*MAP-3*
Source:	Co^{57}
Note:	This sheet supersedes all previous sheets for the XRF instrument of the make, model, and source shown above.

EVALUATION DATA SOURCE AND DATE:

This sheet is supplemental information to be used in conjunction with Chapter 7 of the H *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelin Performance parameters shown on this sheet are calculated from evaluation data collected during EPA/HUD field evaluation study conducted from March through October 1993. The data were collec from four instruments at approximately 1,200 15-second test locations and 300 60-second test locat One instrument had a January 1993 source and the other three instruments had July 1993 sources four instruments had sources with 40 mCi initial strengths. The results of this study are reported in *A F Test of Lead-Based Paint Testing Technologies: Technical Report*, EPA 747-R-95-002b, May 1995

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS:

Performance parameters shown in this sheet are applicable only when operating the instru under the same conditions as the evaluation testing and using the procedures described in Chapte the HUD Guidelines. Operating parameters include:

- Manufacturer-recommended warm-up and quality control procedures
- Use the Multifamily Decision Flowchart for determining the presence of lead on a component type in multifamily housing
- Nominal 15-second or nominal 60-second readings on three locations per component for single-family housing and one location per component for multifamily housing
- Calibration checks are taken using the red (1.02 mg/cm^2) NIST Standard Reference Material (SRM No. 2579) paint film
- Readings for determining the substrate correction values are taken on bare substrate covered with red (1.02 mg/cm^2) NIST SRM paint film
- Lead-based paint is defined as paint with lead equal to or in excess of 1.0 mg/cm^2.

XRF PERFORMANCE CHARACTERISTICS SHEET
Advanced Detectors; LeadStar

TESTING TIMES:

For *Fixed Mode*, the LeadStar instrument tests for a set length of time before a result is obtained and displayed. For *Brief Mode*, the LeadStar instrument tests until a reading is obtained relative to an operator set *Action Level*. The following table provides a summary of testing times for readings taken in *Brief Mode* with an *Action Level* set to 1.0 mg/cm^2. All times have been scaled relative to an initial source strength of 15 mCi. Note that source strength and factors such as substrate may affect testing times.

Results from testing in August 1996 and September 1996

BRIEF MODE TESTING TIMES* (Seconds)						
SUBSTRATE	ALL DATA			MEDIAN FOR LABORATORY-MEASURED LEAD LEVELS (mg/cm^2)		
	25th Percentile	Median	75th Percentile	Pb < 0.25	0.25 ≤ Pb < 1.0	1.0 ≤ Pb
Wood Drywall	7	7	8	7	8	7
Metal	7	7	8	7	8	7
Brick Concrete Plaster	8	8	9	8	8	8

*Testing times are based on readings obtained relative to a 1.0 mg/cm^2 *Action Level*.

XRF PERFORMANCE CHARACTERISTICS SHEET
Advanced Detectors; LeadStar

BIAS AND PRECISION:

Do not use these bias and precision data to correct for substrate bias. These bias and prec data were computed without substrate correction from samples with reported laboratory results les 4.0 mg/cm^2 lead. There were 15 test locations taken in *Fixed Mode* with a laboratory reported resul to or greater than 4.0 mg/cm^2 lead. The fifteen test locations were each tested four times in *Fixed M* once under software version 4.05, once under software version 4.08, and twice under software v 4.30. Of the 15 test locations tested under software version 4.05, one case resulted in an XRF r was less than 1.0 mg/cm^2. Of the 45 test locations tested under software versions 4.08 and 4.30, were no instances in which an XRF reading was less than 1.0 mg/cm^2. Each of the fifteen test loca were tested in *Brief Mode* twice, both under software version 4.30. Out of the 30 *Brief Mode* cases, there were no instances in which an XRF reading was less than 1.0 mg/cm^2. The followin are for illustrative purposes only. Actual bias must be determined on-site. Inconclusive ranges pro above already account for bias and precision. Units are in mg/cm^2.

For those instruments with software versions 4.1 to 4.30.

FIXED MODE READINGS MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	PRECISION* (mg/cm^2)
0.0 mg/cm^2	Brick	0.0	0.1
	Concrete	0.0	0.1
	Drywall	0.0	0.1
	Metal	0.1	0.1
	Plaster	-0.1	0.1
	Wood	0.0	0.1
0.5 mg/cm^2	Brick	0.1	0.2
	Concrete	0.1	0.2
	Drywall	0.0	0.2
	Metal	0.1	0.2
	Plaster	0.0	0.2
	Wood	0.1	0.2
1.0 mg/cm^2	Brick	0.1	0.3
	Concrete	0.1	0.3
	Drywall	0.1	0.3
	Metal	0.2	0.3
	Plaster	0.0	0.3
	Wood	0.1	0.3
2.0 mg/cm^2	Brick	0.2	0.4
	Concrete	0.2	0.4
	Drywall	0.2	0.4
	Metal	0.3	0.4
	Plaster	0.1	0.4
	Wood	0.2	0.4

*Precision at 1 standard deviation

negative if they are less than or equal to the lower limit of the inconclusive range. Thresholds and inconclusive ranges reported here were determined for comparing results to the 1.0 mg/cm^2 standard. For a listing of laboratories recommended by the EPA National Lead Laboratory Accreditation Program (NLLAP) for the analysis of samples to resolve an inconclusive XRF result or additional confirmational analysis, call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

For those instruments with software versions 4.1 to 4.30. (This guidance may be used for software versions higher than 4.30 if the higher software version incorporates the same signal processing and data treatment algorithms that are in software version 4.30).

15-SECOND FIXED MODE READING DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)	INCONCLUSIVE RANGE (mg/cm^2)
Results not corrected for substrate bias	Brick	None	0.9 to 1.1
	Concrete	None	0.9 to 1.1
	Drywall	None	0.9 to 1.1
	Metal	None	0.9 to 1.2
	Plaster	1.0	None
	Wood	None	0.9 to 1.1

BRIEF MODE READING DESCRIPTION	SUBSTRATE	THRESHOLD in mg/cm^2
Results not corrected for substrate bias	Brick	1.0
	Concrete	1.0
	Drywall	1.0
	Metal	1.0
	Plaster	1.0
	Wood	1.0

For those instruments with software versions earlier than version 4.1.

15-SECOND FIXED MODE READING DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE in mg/cm^2
Results corrected for substrate bias for readings on metal substrates only	Brick	0.9 to 1.3
	Concrete	0.9 to 1.3
	Drywall	0.9 to 1.1
	Metal	0.9 to 1.1
	Plaster	0.9 to 1.1
	Wood	0.9 to 1.1

INSTRUCTIONS FOR EVALUATING XRF TESTING:

Chapter 7 of the HUD Guidelines recommends several options for evaluating XRF testing. Among those options is the following procedure which may be used after XRF testing has been completed. In single-family housing, an XRF result is the average of three readings taken on a testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). In multifamily housing, an XRF result is a single reading taken on a testing combination. If a multifamily

housing development is being retested, randomly select two units from within the development from the ten testing combinations should be randomly selected.

Randomly select ten testing combinations for retesting from each house or from the two selected

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the orig or retest results for substrate bias. In single-family housing a result is defined as average of three readings. In multifamily housing, a result is a single reading. There there will be ten original and ten retest XRF results for each house or for the two sele units.

Compute the average of the original and re-test result for each of the ten testing combina

Square the average for each testing combination.

Add the ten squared averages together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the overall average of all ten retest XRF results over all ten testing combinations selected for retesting.

Take the difference of the overall average of the ten original XRF results and the overall average of the ten retest XRF results. If the difference is negative, drop the negative sign.

If the difference of the overall averages is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. The results of this procedure will call for further examination when no examination is warranted approximately 1 out of 100 dwelling units tested.

XRF PERFORMANCE CHARACTERISTICS SHEET
Advanced Detectors; LeadStar

XRF CALIBRATION CHECK:

Chapter 7 of the HUD Guidelines recommends using a calibration check procedure to determine the operating condition of the XRF instrument. For this instrument, calibration check readings should be taken in *Fixed Mode*. If the observed calibration check average minus 1.02 mg/cm^2 is greater than the positive (plus) calibration check tolerance value, or less than the negative (minus) calibration check tolerance value, then the instructions provided by the manufacturer should be followed in order to bring the instrument back into control before any more XRF testing is done. This calibration check is estimated to produce an incorrect result (that is, a finding that the instrument is out of calibration) very infrequently - once out of every 200 times this procedure is followed.

Use the following calibration check tolerance values for *Fixed Mode* readings for those instruments with software versions 4.1 to 4.30. (This guidance may be used for software versions higher than 4.30 if the higher software version incorporates the same signal processing and data treatment algorithms that are in software version 4.30).

minus value = -0.2 mg/cm^2
plus value = +0.0 mg/cm^2

Use the following calibration check tolerance values for *Fixed Mode* readings for those instruments with software versions earlier than version 4.1.

minus value = -0.2 mg/cm^2
plus value = +0.1 mg/cm^2

(Operators may choose to use limits in the manufacturer's operations manual for this calibration check. The rate of an incorrect result if the limits in the manufacturer's operations manual are followed may be different from the rate of an incorrect result stated here.)

FOR XRF RESULTS BELOW 4.0 mg/cm^2, SUBSTRATE CORRECTION RECOMMENDED FOR:

For those instruments with software versions 4.1 to 4.30. (This guidance may be used for software versions higher than 4.30 if the higher software version incorporates the same signal processing and data treatment algorithms that are in software version 4.30).

none

For those instruments with software versions earlier than version 4.1

Metal

SUBSTRATE CORRECTION NOT RECOMMENDED FOR:

For those instruments with software versions 4.1 to 4.30.

Brick, Concrete, Drywall, Metal, Plaster, and Wood

XRF PERFORMANCE CHARACTERISTICS SHEET
Advanced Detectors; LeadStar

For those instruments with software versions earlier than version 4.1.

Brick, Concrete, Drywall, Plaster, and Wood

SUBSTRATE CORRECTION VALUE COMPUTATION:

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate b Supplemental guidance for using the red (1.02 mg/cm^2) NIST SRM paint film for substrate correctio provided below.

XRF results are corrected for substrate bias by subtracting from each XRF result a correction va determined separately in each house for single-family housing or in each development for multif housing, for each substrate. The correction value is an average of XRF readings taken over red SRM (1.02 mg/cm^2) paint films at test locations that had been scraped clean of their paint cover Compute the correction values as follows:

- Using the same XRF instrument, take three readings on a bare substrate area covered with red NIST SRM (1.02 mg/cm^2) paint film. Repeat this procedure by taking three more readings a second bare substrate area of the same substrate covered with the red NIST SRM mg/cm^2) paint film.

- Compute the correction value for each substrate type by computing the average of all six read as shown below.

For each substrate type recommended for substrate correction:

$$\left.\begin{matrix}\textit{Correction}\\ \textit{Value}\end{matrix}\right\} = \frac{1^{st} + 2^{nd} + 3^{rd} + 4^{th} + 5^{th} + 6^{th}\ \textit{Reading}}{6} - 1.02 mg/cm^2$$

INCONCLUSIVE RANGE OR THRESHOLD:

XRF results are classified using either the threshold or the inconclusive range. In single-fam housing, an XRF result is the average of three readings taken on a testing combination. (A tes combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines) multifamily housing, an XRF result is a single reading taken on a testing combination. For computing XRF result, use all digits that are reported by the instrument. For the threshold, results are classified positive if they are greater than or equal to the threshold, and negative if they are less than the thres There is no inconclusive classification when using the threshold. For the inconclusive range, results classified as positive if they are greater than or equal to the upper limit of the inconclusive range, a

XRF PERFORMANCE CHARACTERISTICS SHEET
Scitec Corporation; MAP 4

BIAS AND PRECISION (continued):

TEST MODE READING MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	PRECISION* (mg/cm^2)
0.0 mg/cm^2	Brick	-0.1	0.2
	Concrete	-0.1	0.2
	Drywall	0.1	0.1
	Metal	0.1	0.2
	Plaster	-0.1	0.2
	Wood	0.0	0.1
0.5 mg/cm^2	Brick	-0.1	0.3
	Concrete	-0.1	0.3
	Drywall	0.3	0.4
	Metal	0.2	0.2
	Plaster	-0.1	0.3
	Wood	0.2	0.4
1.0 mg/cm^2	Brick	-0.1	0.3
	Concrete	-0.1	0.3
	Drywall	0.5	0.6
	Metal	0.3	0.2
	Plaster	-0.1	0.3
	Wood	0.4	0.6
1.5 mg/cm^2	Brick	0.0	0.4
	Concrete	0.0	0.4
	Drywall	1.0	0.8
	Metal	0.5	0.2
	Plaster	0.0	0.4
	Wood	0.8	0.8

*Precision at 1 standard deviation

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristics Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7 of the *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead-Based Paint Abatement and Poisoning Prevention, U.S. Department of Housing and Urban Development, Room B-133, 451 Seventh St, S.W., Washington, DC 20410.

XRF PERFORMANCE CHARACTERISTICS SHEET
Advanced Detectors; LeadStar

EFFECTIVE DATE: October 7, 1996 **EDITION N**

MANUFACTURER AND MODEL:

Make:	*Advanced Detectors, Inc.*
Model:	*LeadStar*
Source:	Co^{57}
Note:	This sheet supersedes all previous sheets for the XRF instrument of the make, model, and source shown above.

EVALUATION DATA SOURCE AND DATE:

This sheet is supplemental information to be used in conjunction with Chapter 7 of the H *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelin Performance parameters shown on this sheet are calculated from the EPA/HUD evaluation using archi building components. Testing was conducted on approximately 150 test locations. All of the test locatic were tested twice in 1995, in June and in August. Two instruments (both installed with software ve 4.05) were used in the June 1995 testing and one instrument (with software version 4.08) was used i August 1995 testing. All three instruments had a June 1995 source at 15 mCi initial strength. The sa test locations were tested twice again in 1996, in August and in September. One instrument (with soft version 4.30) was used in the August 1996 testing, with a July 1996 source at 15 mCi initial strength. instrument (also with software version 4.30) was used in the September 1996 testing, with an August 1 source at 15 mCi initial strength. Each instrument had a distinct serial number.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS:

Performance parameters shown in this sheet are applicable only when operating the instrum under the same conditions as the evaluation testing and using the procedures described in Chapter the HUD Guidelines. Operating parameters include:

- Manufacturer-recommended warm-up and quality control procedures
- Use the Multifamily Decision Flowchart for determining the presence of lead on a component type in multifamily housing
- Take readings on three locations per component for single-family housing and one location per component for multifamily housing
- Calibration checks are taken using the red (1.02 mg/cm^2) NIST Standard Reference Material (SRM No. 2579) paint film
- Readings for determining the substrate correction values are taken on bare substrate covered with red (1.02 mg/cm^2) NIST SRM paint film
- Lead-based paint is defined as paint with lead equal to or in excess of 1.0 mg/cm^2.

XRF PERFORMANCE CHARACTERISTICS SHEET
Scitec Corporation; MAP 4

TESTING TIMES (continued):

SCREEN MODE TESTING TIMES (Seconds)						
SUBSTRATE*	ALL DATA			MEDIAN FOR LABORATORY-MEASURED LEAD LEVELS (mg/cm²)		
	25th Percentile	Median	75th Percentile	Pb < 0.25	0.25 ≤ Pb < 1.0	1.0 ≤ Pb
Wood Drywall	4	6	7	5	6	7
Metal	4	5	6	5	5	5
Brick Concrete Plaster	11	11	13	11	11	11

*The general calibration was used for wood, drywall, brick, concrete, plaster. Steel calibration was used for metal. (There are no aluminum samples in the archive facility).

TEST MODE TESTING TIMES (Seconds)						
SUBSTRATE	ALL DATA			MEDIAN FOR LABORATORY-MEASURED LEAD LEVELS (mg/cm²)		
	25th Percentile	Median	75th Percentile	Pb < 0.25	0.25 ≤ Pb < 1.0	1.0 ≤ Pb
Wood Drywall	17	22	27	21	20	28
Metal	13	20	23	20	20	20
Brick Concrete Plaster	41	42	52	41	46	43

*The general calibration was used for wood, drywall, brick, concrete, plaster. Steel calibration was used for metal. (There are no aluminum samples in the archive facility).

XRF PERFORMANCE CHARACTERISTICS SHEET
Scitec Corporation; MAP 4

BIAS AND PRECISION:

Do not use these bias and precision data to correct for substrate bias. These bias and precis data were computed without substrate correction from samples with laboratory-measured lead levels l than 4.0 mg/cm^2 lead. There were 15 testing locations taken in the screen mode with a labor measured lead levels equal to or greater than 4.0 mg/cm^2 lead. None of these had XRF reading than 1.0 mg/cm^2. There were 15 testing locations taken in the test mode with a laboratory-measured l levels equal to or greater than 4.0 mg/cm^2 lead. None of these had XRF readings less than 1.0 mg/c There were not any testing locations taken in the confirm mode with a laboratory-measured lead equal to or greater than 4.0 mg/cm^2 lead. There were 15 testing locations taken in the unlimited with a laboratory-measured lead levels equal to or greater than 4.0 mg/cm^2 lead. None of these had X readings less than 1.0 mg/cm^2. All testing was done in February 1996 with two different instruments following data are for illustrative purposes only. Actual bias must be determined on the site. Inconcl ranges provided above already account for bias and precision. Units are in mg/cm^2.

SCREEN MODE READING MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	PRECISION* (mg/cm^2)
0.0 mg/cm^2	Brick	-0.1	0.3
	Concrete	-0.1	0.3
	Drywall	0.1	0.2
	Metal	0.1	0.3
	Plaster	-0.1	0.3
	Wood	0.0	0.2
0.5 mg/cm^2	Brick	0.0	0.3
	Concrete	0.0	0.3
	Drywall	0.3	0.4
	Metal	0.2	0.3
	Plaster	0.0	0.3
	Wood	0.2	0.4
1.0 mg/cm^2	Brick	0.1	0.4
	Concrete	0.1	0.4
	Drywall	0.5	0.6
	Metal	0.3	0.3
	Plaster	0.1	0.4
	Wood	0.4	0.6
2.0 mg/cm^2	Brick	0.4	0.5
	Concrete	0.4	0.5
	Drywall	0.9	0.8
	Metal	0.5	0.3
	Plaster	0.4	0.5
	Wood	0.7	0.8

*Precision at 1 standard deviation

XRF PERFORMANCE CHARACTERISTICS SHEET
Scitec Corporation; MAP 4

SCREEN MODE READING DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE (mg/cm^2)
Results corrected for substrate bias for screen mode readings on drywall, metal, and wood substrates only	Brick	0.9 to 1.1
	Concrete	0.9 to 1.1
	Drywall	0.9 to 1.4
	Metal	0.9 to 1.2
	Plaster	0.9 to 1.1
	Wood	0.9 to 1.3

TEST MODE READING DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)	INCONCLUSIVE RANGE (mg/cm^2)
Readings corrected for substrate bias for test mode readings on drywall, metal, and wood substrates only	Brick	0.9	None
	Concrete	0.9	None
	Drywall	None	0.9 to 1.4
	Metal	None	0.9 to 1.1
	Plaster	0.9	None
	Wood	None	0.9 to 1.3

INSTRUCTIONS FOR EVALUATING XRF TESTING:

Chapter 7 of the HUD Guidelines recommends several options for evaluating XRF testing. Among those options is the following procedure which may be used after XRF testing has been completed. In single-family housing, an XRF result is the average of three readings taken on a testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). In multifamily housing, an XRF result is a single reading taken on a testing combination. If a multifamily housing development is being retested, randomly select two units from within the development from which the ten testing combinations should be randomly selected. Use either 15-second readings or 60-second readings.

Randomly select ten testing combinations for retesting from each house or from the two selected units.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family housing a result is defined as the average of three readings. In multifamily housing, a result is a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Compute the average of the original and re-test result for each of the ten testing combinations.

Square the average for each testing combination.

Add the ten squared averages together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the overall average of all ten retest XRF results over all ten testing combinations selected for retesting.

Take the difference of the overall average of the ten original XRF results and the overall average of the ten retest XRF results. If the difference is negative, drop the negative sign.

If the difference of the overall averages is less than the Retest Tolerance Limit, the inspection ha passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a secon time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. Tha results of this procedure will call for further examination when no examination is warrant approximately 1 out of 100 dwelling units tested.

TESTING TIMES:

For screen, test, and confirm modes, the MAP 4 instrument tests until a K-shell result is obta relative to a level of precision. A result is "positive", "negative" or "retest" as displayed by indicator For the unlimited mode, the MAP 4 instrument tests until a K-shell result is indicated relative to an level (1.0 mg/cm^2 for archive testing) and the current precision, or until the the reading is terminate releasing the trigger. A few unlimited mode readings were terminated because they exceeded the minute limit used for archive testing. The following tables provide testing time information for three t modes. Insufficient information is available to provide this information for confirm mode. All times been scaled to match an initial 12 miC source. Note that source strength and factors such as subst may affect testing times.

UNLIMITED MODE TESTING TIMES (Seconds)						
SUBSTRATE*	ALL DATA			MEDIAN FOR LABORATORY-MEASURED LEAD LEVELS (mg/cm^2)		
	25th Percentile	Median	75th Percentile	Pb < 0.25	0.25 ≤ Pb < 1.0	1.0 ≤ P
Wood Drywall	3	4	6	4	13	3
Metal	3	4	8	4	9	3
Brick Concrete Plaster	4	5	8	6	6	3

*The general calibration was used for wood, drywall, brick, concrete, plaster. Steel calibration was used for metal. (There are no aluminum samples in the archive facility).

the ten testing combinations should be randomly selected.

Randomly select ten testing combinations for retesting from each house or from the two selected units.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and repeat XRF readings. Do not correct the original or retest results for substrate bias. In single-family housing a result is defined as the average of three readings. In multifamily housing, a result is a single reading. Therefore, there will be ten original and ten repeat XRF results for each house or for the two selected units.

Compute the square of each of the ten original and ten repeat XRF results.

Add these squares of XRF results together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the overall average of all ten original XRF results over all ten testing combinations selected for retesting.

Compute the overall average of all ten repeat XRF results over all ten testing combinations selected for retesting.

Take the difference of the overall average of the ten original XRF results and the overall average of the ten repeat XRF results. If the difference is negative, drop the negative sign.

If the difference of the overall averages is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

XRF PERFORMANCE CHARACTERISTICS SHEET
Princeton Gamma-Tech, Inc.; XK-3

BIAS AND PRECISION:

Do not use these bias and precision data to correct for substrate bias. These bias and precision d were computed without substrate correction from samples with reported laboratory results less than 4. mg/cm^2 lead. There were 143 testing locations with a laboratory reported result equal to or greater tha 4.0 mg/cm^2 lead. Of these, 1 had an XRF reading less than 1.0 mg/cm^2. These data are for illustrat purposes only. Actual bias must be determined on the site. Inconclusive ranges provided above alread account for bias and precision. Bias and precision ranges are provided whenever significant variability wa found between machines of the same model. Units are in mg/cm^2.

MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	BIAS RANGES (mg/cm^2)	PRECISION* (mg/cm^2)	PRECISION RANGES (mg/cm^2)
0.0 mg/cm^2	Brick	0.9	-	0.6	-
	Concrete	1.3	(0.6, 1.9)	0.6	(0.2, 0.6)
	Drywall	-0.1	(-0.3, 0.2)	0.3	(0.2, 0.3)
	Metal	0.9	(0.5, 1.4)	0.5	(0.4, 0.5)
	Plaster	0.8	(0.4, 1.7)	0.5	(0.4, 0.5)
	Wood	0.2	(-0.1, 1.0)	0.4	(0.3, 0.5)
0.5 mg/cm^2	Brick	0.9	-	0.6	-
	Concrete	1.3	(0.7, 1.9)	0.6	(0.5, 0.7)
	Drywall	0.0	(-0.2, 0.2)	0.4	(0.3, 0.4)
	Metal	1.1	(0.7, 1.6)	0.8	(0.4, 0.9)
	Plaster	0.8	(0.2, 1.6)	0.6	(0.4, 0.6)
	Wood	0.4	(0.1, 1.1)	0.6	(0.3, 0.9)
1.0 mg/cm^2	Brick	0.9	-	0.6	-
	Concrete	1.3	(0.7, 2.0)	0.7	(0.6, 0.8)
	Drywall	0.0	(-0.1, 0.2)	0.4	(0.4, 0.5)
	Metal	1.3	(0.9, 1.7)	1.0	(0.5, 1.1)
	Plaster	0.8	(0.0, 1.6)	0.6	(0.4, 0.7)
	Wood	0.6	(0.3, 1.3)	0.7	(0.3, 1.2)
2.0 mg/cm^2	Brick	0.9	-	0.6	-
	Concrete	1.3	(0.7, 2.0)	0.8	(0.6, 0.9)
	Drywall	0.1	(0.1, 0.2)	0.6	(0.5, 0.6)
	Metal	1.7	(1.4, 2.1)	1.4	(0.6, 1.6)
	Plaster	0.7	(-0.3, 1.6)	0.7	(0.4, 0.8)
	Wood	1.0	(0.8, 1.5)	0.9	(0.3, 1.7)

*Precision at 1 standard deviation

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanat of the statistical methodology used to construct the data in the sheets and provides empirical results fr using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy c this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristic Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7 of the *Guidelines fo the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead-Based Paint Abatement and Poisoning Prevention, U.S. Department of Housing and Urban Development, Room B-133, 451 Seventh St. S.W., Washington, DC 20410

XRF PERFORMANCE CHARACTERISTICS SHEET
Scitec Corporation; MAP 4

XRF CALIBRATION CHECK:

Chapter 7 of the HUD Guidelines recommends using a calibration check procedure to determine the operating condition of the XRF instrument. For this instrument, calibration checks should be taken in TEST mode. If the observed calibration check average minus 1.02 mg/cm^2 is greater than the positive (plus) calibration check tolerance value, or less than the negative (minus) calibration check tolerance value, then the instructions provided by the manufacturer should be followed in order to bring the instrument back into control before any more XRF testing is done. This calibration check is estimated to produce an incorrect result (that is, a finding that the instrument is out of calibration) very infrequently - once out of every 200 times this procedure is followed.

minus value = -0.4 mg/cm^2
plus value = +0.2 mg/cm^2

WHEN USING UNLIMITED MODE, SUBSTRATE CORRECTION RECOMMENDED FOR:

None

WHEN USING UNLIMITED MODE, SUBSTRATE CORRECTION NOT RECOMMENDED FOR:

Brick, Concrete, Drywall, Metal, Plaster, and Wood

WHEN USING SCREEN OR TEST MODE, FOR XRF RESULTS BELOW 4.0 mg/cm^2, SUBSTRATE CORRECTION RECOMMENDED FOR:

Drywall, Metal, and Wood

WHEN USING SCREEN OR TEST MODE, SUBSTRATE CORRECTION NOT RECOMMENDED FOR:

Brick, Concrete, and Plaster

SUBSTRATE CORRECTION VALUE COMPUTATION:

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bias. Supplemental guidance for using the red (1.02 mg/cm^2) NIST SRM paint film for substrate correction is provided below.

XRF results are corrected for substrate bias by subtracting from each XRF result a correction value determined separately in each house for single-family housing or in each development for multifamily housing, for each substrate. The correction value is an average of XRF readings taken over red NIST SRM (1.02 mg/cm^2) paint films at test locations that had been scraped clean of their paint covering. Compute the correction values as follows:

XRF PERFORMANCE CHARACTERISTICS SHEET
Scitec Corporation; MAP 4

- Using the same XRF instrument, take three readings on a bare substrate area covered with t NIST SRM (1.02 mg/cm^2) paint film. Repeat this procedure by taking thr more readings c second bare substrate area of the same substrate covered with the red NIST M (1.02 mg/cm^2) p film.

- Compute the correction value for each substrate type by computing the average of all six readings shown below.

  For each substrate type:

$$\left.\begin{matrix}\text{Correction} \\ \text{Value}\end{matrix}\right\} = \frac{1^{st} + 2^{nd} + 3^{rd} + 4^{th} + 5^{th} + 6^{th}\ \text{Reading}}{6} - 1.02 mg/cm^2$$

- Repeat this procedure for each substrate tested in the house or housing development.

INCONCLUSIVE RANGE OR THRESHOLD:

XRF results are classified using either the threshold or the inconclusive range. In single-fa housing, an XRF result is the average of three readings taken on a testing combination. (A te combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines multifamily housing, an XRF result is a single reading taken on a testing combination. For computing XRF result, use all digits that are reported by the instrument. For the threshold, results are classifiec positive if they are greater than or equal to the threshold, and negative if they are less than the thres There is no inconclusive classification when using the threshold. For the inconclusive range, result classified as positive if they are greater than or equal to the upper limit of the inconclusive range, negative if they are less than or equal to the lower limit of the inconclusive range. Threshold inconclusive ranges were determined for comparing results to the 1.0 mg/cm^2 standard. For a list laboratories recommended by the EPA National Lead Laboratory Accreditation Program (NLLAP) for analysis of samples to resolve an inconclusive XRF result or additional confirmational analysis, call National Lead Information Center Clearinghouse on 1-800-424-LEAD.

UNLIMITED MODE READING DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE (mg/cm^2)
Results not corrected for substrate bias for unlimited mode readings	Brick	0.9 to 1.2
	Concrete	0.9 to 1.2
	Drywall	0.9 to 1.2
	Metal	0.9 to 1.2
	Plaster	0.9 to 1.2
	Wood	0.9 to 1.2

XRF PERFORMANCE CHARACTERISTICS SHEET
Warrington, Inc.; Microlead I revision 4

BIAS AND PRECISION:

Do not use these bias and precision data to correct for substrate bias. These bias and precision data were computed without substrate correction from samples with reported laboratory results less than 4.0 mg/cm^2 lead. There were 143 test locations with a laboratory reported result equal to or greater than 4.0 mg/cm^2 lead. Of these, 1 had an XRF reading less than 1.0 mg/cm^2. These data are for illustrative purposes only. Actual bias must be determined on the site. Inconclusive ranges provided above already account for bias and precision. Bias and precision ranges are provided whenever significant variability was found between machines of the same model. Units are in mg/cm^2.

MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	BIAS RANGES (mg/cm^2)	PRECISION* (mg/cm^2)	PRECISION RANGES (mg/cm^2)
0.0 mg/cm^2	Brick	0.1	-	0.6	-
	Concrete	0.3	(0.0, 0.9)	0.6	(0.5, 1.2)
	Drywall	0.0	(0.0, 0.7)	0.3	(0.3, 0.5)
	Metal	-0.3	(-0.4, 1.1)	0.5	(0.3, 0.8)
	Plaster	0.1	(-0.3, 0.2)	0.5	(0.3, 0.6)
	Wood	0.4	(0.0, 0.5)	0.6	(0.5, 0.8)
0.5 mg/cm^2	Brick	-	-	-	-
	Concrete	0.3	(0.1, 1.1)	0.6	(0.5, 1.3)
	Drywall	0.1	(0.1, 1.3)	0.3	(0.3, 0.5)
	Metal	-0.2	(-0.3, 1.2)	0.6	(0.5, 0.8)
	Plaster	0.1	(-0.3, 0.1)	0.6	(0.4, 0.8)
	Wood	0.7	(0.2, 0.7)	0.7	(0.6, 0.8)
1.0 mg/cm^2	Brick	-0.3	-	0.6	-
	Concrete	0.3	(0.2, 1.2)	0.7	(0.6, 1.4)
	Drywall	0.2	(0.2, 1.9)	0.3	(0.3, 0.5)
	Metal	-0.1	(-0.1, 1.4)	0.6	(0.5, 0.8)
	Plaster	0.1	(-0.3, 0.3)	0.7	(0.5, 1.0)
	Wood	1.0	(0.3, 1.0)	0.7	(0.6, 0.8)
●.0 mg/cm^2	Brick	-	-	-	-
	Concrete	0.2	(0.2, 1.5)	0.8	(0.7, 1.7)
	Drywall	0.4	(0.1, 3.1)	0.3	(0.3, 0.5)
	Metal	0.2	(0.1, 1.7)	0.7	(0.5, 0.8)
	Plaster	0.2	(-0.3, 0.7)	0.9	(0.6, 1.2)
	Wood	1.6	(0.6, 1.7)	0.8	(0.7, 0.8)

*Precision at 1 standard deviation

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristic Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7 of the *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead-Based Paint Abatement and Poisoning Prevention, U.S. Department of Housing and Urban Development, Room B-133, 451 Seventh St, S.W., Washington, DC 20410.

XRF PERFORMANCE CHARACTERISTICS SHEET
Scitec Corporation; MAP 4

EFFECTIVE DATE: June 26, 1996 **EDITION N**

MANUFACTURER AND MODEL:

Make:	*Scitec Corporation*
Model:	*MAP 4*
Source:	Co^{57}
Note:	This sheet supersedes all previous sheets for the XRF instrument of the make, model, and source shown above.

EVALUATION DATA SOURCE AND DATE:

This sheet is supplemental information to be used in conjunction with Chapter 7 of the H *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelin Performance parameters shown on this sheet are calculated from an EPA/HUD evaluation using arc building components. Testing was conducted on approximately 150 test locations. All of the test locati were tested in February 1996 using two different instruments. One instrument had a new source insta in July 1994 and its strength at the time of testing was calculated as 9.4 mCi. The other instrumen a new source installed in September 1994 and its strength at the time of testing was calculated as mCi.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS:

Performance parameters shown in this sheet are applicable only when operating the instrum under the same conditions as the evaluation testing and using the procedures described in Chapte the HUD Guidelines. Operating parameters include:

- Manufacturer-recommended warm-up and quality control procedures
- Use the Multifamily Decision Flowchart for determining the presence of lead on a component type in multifamily housing
- Take readings on three locations per component for single-family housing and one location per component for multifamily housing
- Calibration checks are taken in test mode while using the red (1.02 mg/cm^2) NIST Standard Reference Material (SRM No. 2579) paint film
- Readings for determining the substrate correction values are taken on bare substrate covered with red (1.02 mg/cm^2) NIST SRM paint film
- Lead-based paint is defined as paint with lead equal to or in excess of 1.0 mg/cm^2.

Appendix E: Executive Summary Table

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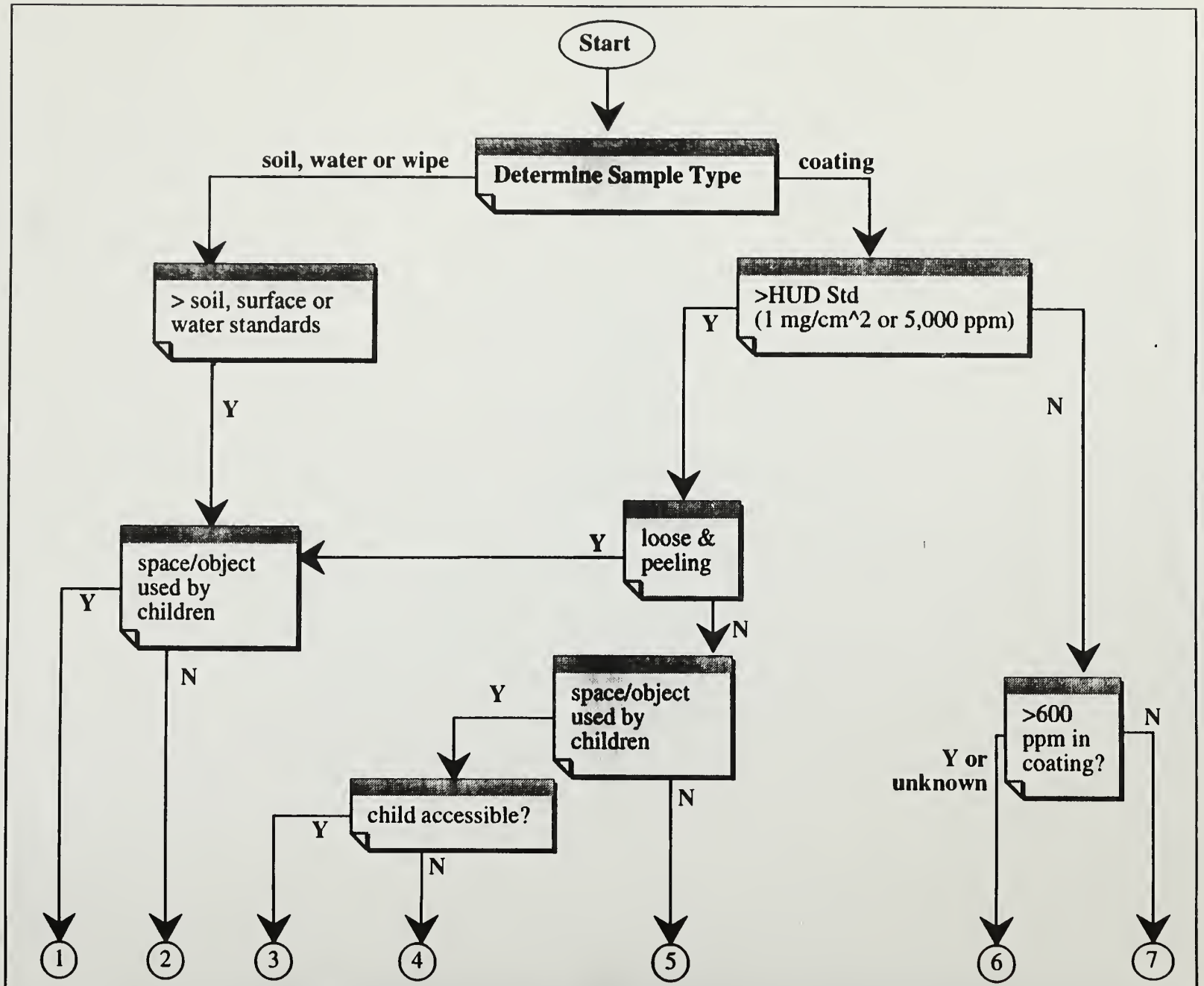

Decision Tree for Lead Sampling Results Assessment.
Prepared and Copyrighted by SCA Environmental, Inc. Updated April 11, 1997.

f/d: SFUSD
lead tree/siu250

XRF PERFORMANCE CHARACTERISTICS SHEET
Radiation Monitoring Devices; LPA-1

EFFECTIVE DATE: November 27, 1995 **EDITION NO.** 1

MANUFACTURER AND MODEL:

Make:	*Radiation Monitoring Devices*
Model:	*LPA-1*
Source:	Co^{57}
Note:	This sheet supersedes all previous sheets for the XRF instrument of the make, model, and source shown above.

EVALUATION DATA SOURCE AND DATE.

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated from the EPA/HUD evaluation using archived building components. Testing was conducted on approximately 150 test locations. All of the test locations were tested three times, once in March 1995, once in July 1995, and once in September 1995 using three distinct instruments. The instrument that performed testing in March had a new source installed in January 1995 with 12 mCi initial strength. The instrument that performed testing in July had a new source installed in June 1995 with 12 mCi initial strength. The instrument that performed testing in September had a new source installed in February 1995 with 12 mCi initial strength. LPA-1 instruments that were purchased before June 26, 1995 and have not been serviced since June 26, 1995 have a different version of firmware than those instruments sold or serviced after June 26, 1995. Therefore, this sheet distinguishes between instruments sold prior to June 26, 1995 and have not been serviced since June 26, 1995 from those instruments serviced or sold after this date.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS:

Performance parameters shown in this sheet are applicable only when operating the instrument under the same conditions as the evaluation testing and using the procedures described in Chapter 7 of the HUD Guidelines. Operating parameters include:

- Manufacturer-recommended warm-up and quality control procedures
- Use the Multifamily Decision Flowchart for determining the presence of lead on a component type in multifamily housing
- Quick mode, nominal 20-second standard mode, or nominal 30-second standard mode readings on three locations per component for single-family housing and one location per component for multifamily housing
- The nominal reading time for standard mode readings must be adjusted to account for source decay
- Calibration checks are taken using nominal 30-second standard mode readings and the red (1.02 mg/cm^2) NIST Standard Reference Material (SRM No. 2579) paint film

XRF PERFORMANCE CHARACTERISTICS SHEET
Radiation Monitoring Devices; LPA-1

SUBSTRATE CORRECTION NOT RECOMMENDED FOR:

For those instruments sold prior to June 26, 1995 and have not been serviced since June 26, 1995:

- Brick, Concrete, Drywall, and Plaster using quick mode or either 20-second or 30-second standard mode readings

For those instruments sold or serviced after June 26, 1995:

- Brick, Concrete, Drywall, Plaster, and Wood using 30-second standard mode readings
- Brick, Concrete, Drywall, Metal, Plaster, and Wood using quick mode readings

SUBSTRATE CORRECTION VALUE COMPUTATION:

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bias. Supplemental guidance for using the red (1.02 mg/cm^2) NIST SRM paint film for substrate correction is provided below.

XRF results are corrected for substrate bias by subtracting from each XRF result a correction value determined separately in each house for single-family housing or in each development for multifamily housing, for each substrate. The correction value is an average of XRF readings taken over red NIST SRM (1.02 mg/cm^2) paint films at test locations that had been scraped clean of their paint covering. Compute the correction values as follows:

- Using the same XRF instrument, take three readings on a bare substrate area covered with the red NIST SRM (1.02 mg/cm^2) paint film. Repeat this procedure by taking three more readings on a second bare substrate area of the same substrate.

- Compute the correction value for each substrate type by computing the average of all six readings as shown below.

For each substrate type:

$$\left.\begin{matrix}\text{Correction} \\ \text{Value}\end{matrix}\right\} = \frac{1^{st} + 2^{nd} + 3^{rd} + 4^{th} + 5^{th} + 6^{th}\ \text{Reading}}{6} - 1.02 \text{mg/cm}^2$$

- Repeat this procedure for each substrate tested in the house or housing development as needed.

XRF PERFORMANCE CHARACTERISTICS SHEET
Radiation Monitoring Devices; LPA-1

For those instruments sold prior to June 26, 1995 and have not been serviced since June 26, 1995:

QUICK MODE READING DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE (mg/cm^2)
Results corrected for substrate bias on metal and wood substrates only	Brick	0.7 - 0.8
	Concrete	0.7 - 0.8
	Drywall	0.6 - 0.8
	Metal	0.9 - 1.0
	Plaster	0.7 - 0.8
	Wood	0.7 - 0.9

For those instruments sold or serviced after June 26, 1995:

30-SECOND STANDARD MODE READING DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)
Results corrected for substrate bias on metal substrate only	Brick	1.0
	Concrete	1.0
	Drywall	1.0
	Metal	0.9
	Plaster	1.0
	Wood	1.0

For those instruments sold or serviced after June 26, 1995:

QUICK MORE READING DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)	INCONCLUSIVE RANGE (mg/cm^2)
Readings not corrected for substrate bias on any substrate	Brick	1.0	None
	Concrete	1.0	None
	Drywall	1.0	None
	Metal	None	0.9 to 1.3
	Plaster	None	0.9 to 1.0
	Wood	1.0	None

INSTRUCTIONS FOR EVALUATING XRF TESTING:

Chapter 7 of the HUD Guidelines recommends several options for evaluating XRF testing. Among those options is the following procedure which may be used after XRF testing has been completed. In single-family housing, an XRF result is the average of three readings taken on a testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). In multifamily housing, an XRF result is a single reading taken on a testing combination. If a multifamily

Appendix D: Decision Tree - Graphical Version

XRF PERFORMANCE CHARACTERISTICS SHEET
Radiation Monitoring Devices: LPA-1

BIAS AND PRECISION:

Do not use these bias and precision data to correct for substrate bias. These bias and precision data were computed without substrate correction from samples with reported laboratory results less than 4.0 mg/cm^2 lead. The data which were used to determine the bias and precision estimates given in the three tables above have the following properties. During the March testing, there were 11 test locations with a laboratory reported result equal to or greater than 4.0 mg/cm^2 lead. Of these, one 20-second standard mode reading was less than 1.0 mg/cm^2 and none of the quick mode readings were less than 1.0 mg/cm^2. During the July testing, there were 15 test locations with a laboratory reported result equal to or greater than 4.0 mg/cm^2 lead. Of these, one 30-second standard mode reading was less than 1.0 mg/cm^2 and none of the quick mode readings were less than 1.0 mg/cm^2. During the September testing, there were 15 test locations with a laboratory reported result equal to or greater than 4.0 mg/cm^2 lead. Of these, two 20-second and one 30-second standard mode readings were less than 1.0 mg/cm^2, and one quick mode reading was less than 1.0 mg/cm^2. The two instruments that tested in March and September are representative of instruments sold prior to June 26, 1995 and have not been serviced since June 26, 1995 and the instrument that tested in July is representative of instruments sold or serviced after June 26, 1995. These data are for illustrative purposes only. Actual bias must be determined on the site. Inconclusive ranges provided above already account for bias and precision. Bias and precision ranges are provided to show the variability that was found between machines of the same model. Units are in mg/cm^2

XRF PERFORMANCE CHARACTERISTICS SHEET
Radiation Monitoring Devices; LPA-1

For those instruments sold prior to June 26, 1995 and have not been serviced since June 26, 1995:

30-SECOND READING MEASURED AT	SUBSTRATE	BIAS (mg/cm²)	PRECISION* (mg/cm²)
0.0 mg/cm²	Brick	-0.1	0.1
	Concrete	-0.1	0.1
	Drywall	-0.2	0.1
	Metal	-0.4	0.1
	Plaster	-0.1	0.1
	Wood	-0.1	0.1
0.5 mg/cm²	Brick	-0.2	0.2
	Concrete	-0.2	0.2
	Drywall	-0.3	0.2
	Metal	-0.5	0.2
	Plaster	-0.1	0.2
	Wood	-0.2	0.2
1.0 mg/cm²	Brick	-0.2	0.3
	Concrete	-0.2	0.3
	Drywall	-0.3	0.3
	Metal	-0.6	0.3
	Plaster	-0.2	0.3
	Wood	-0.2	0.3
2.0 mg/cm²	Brick	-0.3	0.4
	Concrete	-0.4	0.4
	Drywall	-0.5	0.4
	Metal	-0.7	0.4
	Plaster	-0.3	0.4
	Wood	-0.4	0.4

*Precision at 1 standard deviation.

XRF PERFORMANCE CHARACTERISTICS SHEET
Radiation Monitoring Devices; LPA-1

For those instruments sold or serviced after June 26, 1995:

30-SECOND STANDARD MODE READING MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	PRECISION* (mg/cm^2)
0.0 mg/cm^2	Brick	0.0	0.1
	Concrete	0.0	0.1
	Drywall	0.1	0.1
	Metal	0.3	0.1
	Plaster	0.1	0.1
	Wood	0.0	0.1
0.5 mg/cm^2	Brick	0.0	0.2
	Concrete	0.0	0.2
	Drywall	0.0	0.2
	Metal	0.2	0.2
	Plaster	0.0	0.2
	Wood	0.0	0.2
1.0 mg/cm^2	Brick	0.0	0.3
	Concrete	0.0	0.3
	Drywall	0.0	0.3
	Metal	0.2	0.3
	Plaster	0.0	0.3
	Wood	0.0	0.3
2.0 mg/cm^2	Brick	-0.1	0.4
	Concrete	-0.1	0.4
	Drywall	-0.1	0.4
	Metal	0.1	0.4
	Plaster	-0.1	0.4
	Wood	-0.1	0.4

*Precision at 1 standard deviation.

XRF PERFORMANCE CHARACTERISTICS SHEET
Warrington, Inc.; Microlead I revision 4

EFFECTIVE DATE: September 25, 1995 **EDITION NO.:** 1

MANUFACTURER AND MODEL:

Make:	*Warrington, Inc.*
Model:	*Microlead I revision 4*
Source:	Co^{57}
Note:	This sheet supersedes all previous sheets for the XRF instrument of the make, model, and source shown above

EVALUATION DATA SOURCE AND DATE:

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated from evaluation data collected during the EPA/HUD field evaluation study conducted from March through October 1993. The data were collected from approximately 1,200 test locations using five instruments with source dates ranging from March 1993 to October 1993. All five instruments had sources with 10 mCi initial strengths. The results of this study are reported in *A Field Test of Lead-Based Paint Testing Technologies: Technical Report*, EPA 747-R-95-002b, May 1995.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS:

Performance parameters shown in this sheet are applicable only when operating the instrument under the same conditions as the evaluation testing and using the procedures described in Chapter 7 of the HUD Guidelines. Operating parameters include:

- Manufacturer-recommended warm-up and quality control procedures
- Use the Multifamily Decision Flowchart for determining the presence of lead on a component type in multifamily housing
- Nominal 15-second readings on three locations per component for single-family housing and one location per component for multifamily housing
- Calibration checks are taken using the red (1.02 mg/cm^2) NIST Standard Reference Material (SRM No. 2579) paint film
- Readings for determining the substrate correction values are taken on bare substrate covered with red (1.02 mg/cm^2) NIST SRM paint film
- Lead-based paint is defined as paint with lead equal to or in excess of 1.0 mg/cm^2.

For each substrate type:

$$\left.\begin{matrix}\textit{Correction}\\ \textit{Value}\end{matrix}\right\} = \frac{1^{st} + 2^{nd} + 3^{rd} + 4^{th} + 5^{th} + 6^{th}\ \textit{Reading}}{6} - 1.02 mg/cm^2$$

- Repeat this procedure for each substrate tested in the house or housing development.

INCONCLUSIVE RANGE:

XRF results are classified as positive if they are greater than or equal to the upper limit of the inconclusive range, and negative if they are less than or equal to the lower limit of the inconclusive range. In single-family housing, an XRF result is the average of three readings taken on a testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). In multifamily housing, an XRF result is a single reading taken on a testing combination. For computing the XRF result, use all digits that are reported by the instrument. Inconclusive ranges were determined for comparing results to the 1.0 mg/cm^2 standard. For a listing of laboratories recommended by the EPA National Lead Laboratory Accreditation Program (NLLAP) for the analysis of samples to resolve an inconclusive XRF result or additional confirmational analysis, call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE in mg/cm^2
Results corrected for substrate bias on all substrates except plaster	Brick	0.8 to 1.3
	Concrete	0.5 to 1.4
	Drywall	0.9 to 1.1
	Metal	0.9 to 1.4
	Plaster	0.7 to 1.6
	Wood	0.9 to 1.6

INSTRUCTIONS FOR EVALUATING XRF TESTING:

Chapter 7 of the *HUD Guidelines* recommends several options for evaluating XRF testing. Among those options is the following procedure which may be used after XRF testing has been completed. In single-family housing, an XRF result is the average of three readings taken on a testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). In multifamily housing, an XRF result is a single reading taken on a testing combination. If a multifamily housing development is being retested, randomly select two units from within the development from which the ten testing combinations should be randomly selected.

Randomly select ten testing combinations for retesting from each house or from the two selected units.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below

XRF PERFORMANCE CHARACTERISTICS SHEET
Warrington, Inc.; Microlead I revision 4

BIAS AND PRECISION:

Do not use these bias and precision data to correct for substrate bias. These bias and precision data were computed without substrate correction from samples with reported laboratory results less than 4.0 mg/cm^2 lead. There were 143 test locations with a laboratory reported result equal to or greater than 4.0 mg/cm^2 lead. Of these, 1 had an XRF reading less than 1.0 mg/cm^2. These data are for illustrative purposes only. Actual bias must be determined on the site. Inconclusive ranges provided above already account for bias and precision. Bias and precision ranges are provided whenever significant variability was found between machines of the same model. Units are in mg/cm^2.

MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	BIAS RANGES (mg/cm^2)	PRECISION* (mg/cm^2)	PRECISION RANGES (mg/cm^2)
0.0 mg/cm^2	Brick	0.1	-	0.6	-
	Concrete	0.3	(0.0, 0.9)	0.6	(0.5, 1.2)
	Drywall	0.0	(0.0, 0.7)	0.3	(0.3, 0.5)
	Metal	-0.3	(-0.4, 1.1)	0.5	(0.3, 0.8)
	Plaster	0.1	(-0.3, 0.2)	0.5	(0.3, 0.6)
	Wood	0.4	(0.0, 0.5)	0.6	(0.5, 0.8)
0.5 mg/cm^2	Brick	-	-	-	-
	Concrete	0.3	(0.1, 1.1)	0.6	(0.5, 1.3)
	Drywall	0.1	(0.1, 1.3)	0.3	(0.3, 0.5)
	Metal	-0.2	(-0.3, 1.2)	0.6	(0.5, 0.8)
	Plaster	0.1	(-0.3, 0.1)	0.6	(0.4, 0.8)
	Wood	0.7	(0.2, 0.7)	0.7	(0.6, 0.8)
1.0 mg/cm^2	Brick	-0.3	-	0.6	-
	Concrete	0.3	(0.2, 1.2)	0.7	(0.6, 1.4)
	Drywall	0.2	(0.2, 1.9)	0.3	(0.3, 0.5)
	Metal	-0.1	(-0.1, 1.4)	0.6	(0.5, 0.8)
	Plaster	0.1	(-0.3, 0.3)	0.7	(0.5, 1.0)
	Wood	1.0	(0.3, 1.0)	0.7	(0.6, 0.8)
2.0 mg/cm^2	Brick	-	-	-	-
	Concrete	0.2	(0.2, 1.5)	0.8	(0.7, 1.7)
	Drywall	0.4	(0.1, 3.1)	0.3	(0.3, 0.5)
	Metal	0.2	(0.1, 1.7)	0.7	(0.5, 0.8)
	Plaster	0.2	(-0.3, 0.7)	0.9	(0.6, 1.2)
	Wood	1.6	(0.6, 1.7)	0.8	(0.7, 0.8)

*Precision at 1 standard deviation

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristic Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7 of the *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead-Based Paint Abatement and Poisoning Prevention, U.S. Department of Housing and Urban Development, Room B-133, 451 Seventh St, S.W., Washington, DC 20410.

XRF PERFORMANCE CHARACTERISTICS SHEET
Scitec Corporation; MAP 4

XRF CALIBRATION CHECK:

Chapter 7 of the HUD Guidelines recommends using a calibration check procedure to determine the operating condition of the XRF instrument. For this instrument, calibration checks should be taken in TEST mode. If the observed calibration check average minus 1.02 mg/cm^2 is greater than the positive (plus) calibration check tolerance value, or less than the negative (minus) calibration check tolerance value, then the instructions provided by the manufacturer should be followed in order to bring the instrument back into control before any more XRF testing is done. This calibration check is estimated to produce an incorrect result (that is, a finding that the instrument is out of calibration) very infrequently - once out of every 200 times this procedure is followed.

minus value = -0.4 mg/cm^2
plus value = +0.2 mg/cm^2

WHEN USING UNLIMITED MODE, SUBSTRATE CORRECTION RECOMMENDED FOR:

None

WHEN USING UNLIMITED MODE, SUBSTRATE CORRECTION NOT RECOMMENDED FOR:

Brick, Concrete, Drywall, Metal, Plaster, and Wood

WHEN USING SCREEN OR TEST MODE, FOR XRF RESULTS BELOW 4.0 mg/cm^2, SUBSTRATE CORRECTION RECOMMENDED FOR:

Drywall, Metal, and Wood

WHEN USING SCREEN OR TEST MODE, SUBSTRATE CORRECTION NOT RECOMMENDED FOR:

Brick, Concrete, and Plaster

SUBSTRATE CORRECTION VALUE COMPUTATION:

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bias. Supplemental guidance for using the red (1.02 mg/cm^2) NIST SRM paint film for substrate correction is provided below.

XRF results are corrected for substrate bias by subtracting from each XRF result a correction value determined separately in each house for single-family housing or in each development for multifamily housing, for each substrate. The correction value is an average of XRF readings taken over red NIST SRM (1.02 mg/cm^2) paint films at test locations that had been scraped clean of their paint covering. Compute the correction values as follows:

XRF PERFORMANCE CHARACTERISTICS SHEET
Scitec Corporation; MAP 4

SCREEN MODE READING DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE (mg/cm^2)
Results corrected for substrate bias for screen mode readings on drywall, metal, and wood substrates only	Brick	0.9 to 1.1
	Concrete	0.9 to 1.1
	Drywall	0.9 to 1.4
	Metal	0.9 to 1.2
	Plaster	0.9 to 1.1
	Wood	0.9 to 1.3

TEST MODE READING DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)	INCONCLUSIVE RANGE (mg/cm^2)
Readings corrected for substrate bias for test mode readings on drywall, metal, and wood substrates only	Brick	0.9	None
	Concrete	0.9	None
	Drywall	None	0.9 to 1.4
	Metal	None	0.9 to 1.1
	Plaster	0.9	None
	Wood	None	0.9 to 1.3

INSTRUCTIONS FOR EVALUATING XRF TESTING:

Chapter 7 of the HUD Guidelines recommends several options for evaluating XRF testing. Among those options is the following procedure which may be used after XRF testing has been completed. In single-family housing, an XRF result is the average of three readings taken on a testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). In multifamily housing, an XRF result is a single reading taken on a testing combination. If a multifamily housing development is being retested, randomly select two units from within the development from which the ten testing combinations should be randomly selected. Use either 15-second readings or 60-second readings.

Randomly select ten testing combinations for retesting from each house or from the two selected units.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family housing a result is defined as the average of three readings. In multifamily housing, a result is a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Compute the average of the original and re-test result for each of the ten testing combinations.

Square the average for each testing combination.

Add the ten squared averages together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

XRF PERFORMANCE CHARACTERISTICS SHEET
Scitec Corporation; MAP 4

TESTING TIMES (continued):

SCREEN MODE TESTING TIMES (Seconds)						
SUBSTRATE[a]	ALL DATA			MEDIAN FOR LABORATORY-MEASURED LEAD LEVELS (mg/cm^2)		
	25th Percentile	Median	75th Percentile	Pb < 0.25	0.25 ≤ Pb < 1.0	1.0 ≤ Pb
Wood Drywall	4	6	7	5	6	7
Metal	4	5	6	5	5	5
Brick Concrete Plaster	11	11	13	11	11	11

[a]The general calibration was used for wood, drywall, brick, concrete, plaster. Steel calibration was used for metal. (There are no aluminum samples in the archive facility).

TEST MODE TESTING TIMES (Seconds)						
SUBSTRATE	ALL DATA			MEDIAN FOR LABORATORY-MEASURED LEAD LEVELS (mg/cm^2)		
	25th Percentile	Median	75th Percentile	Pb < 0.25	0.25 ≤ Pb < 1.0	1.0 ≤ Pb
Wood Drywall	17	22	27	21	20	28
Metal	13	20	23	20	20	20
Brick Concrete Plaster	41	42	52	41	46	43

[a]The general calibration was used for wood, drywall, brick, concrete, plaster. Steel calibration was used for metal. (There are no aluminum samples in the archive facility).

XRF PERFORMANCE CHARACTERISTICS SHEET
Scitec Corporation; MAP 4

BIAS AND PRECISION (continued):

TEST MODE READING MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	PRECISION* (mg/cm^2)
0.0 mg/cm^2	Brick	-0.1	0.2
	Concrete	-0.1	0.2
	Drywall	0.1	0.1
	Metal	0.1	0.2
	Plaster	-0.1	0.2
	Wood	0.0	0.1
0.5 mg/cm^2	Brick	-0.1	0.3
	Concrete	-0.1	0.3
	Drywall	0.3	0.4
	Metal	0.2	0.2
	Plaster	-0.1	0.3
	Wood	0.2	0.4
1.0 mg/cm^2	Brick	-0.1	0.3
	Concrete	-0.1	0.3
	Drywall	0.5	0.6
	Metal	0.3	0.2
	Plaster	-0.1	0.3
	Wood	0.4	0.6
2.0 mg/cm^2	Brick	0.0	0.4
	Concrete	0.0	0.4
	Drywall	1.0	0.8
	Metal	0.5	0.2
	Plaster	0.0	0.4
	Wood	0.8	0.8

*Precision at 1 standard deviation

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristics Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7 of the *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead-Based Paint Abatement and Poisoning Prevention, U.S. Department of Housing and Urban Development, Room B-133, 451 Seventh St. S.W., Washington, DC 20410.

XRF PERFORMANCE CHARACTERISTICS SHEET
Advanced Detectors; LeadStar

XRF CALIBRATION CHECK:

Chapter 7 of the HUD Guidelines recommends using a calibration check procedure to determine the operating condition of the XRF instrument. For this instrument, calibration check readings should be taken in *Fixed Mode*. If the observed calibration check average minus 1.02 mg/cm^2 is greater than the positive (plus) calibration check tolerance value, or less than the negative (minus) calibration check tolerance value, then the instructions provided by the manufacturer should be followed in order to bring the instrument back into control before any more XRF testing is done. This calibration check is estimated to produce an incorrect result (that is, a finding that the instrument is out of calibration) very infrequently - once out of every 200 times this procedure is followed.

Use the following calibration check tolerance values for *Fixed Mode* readings for those instruments with software versions 4.1 to 4.30. (This guidance may be used for software versions higher than 4.30 if the higher software version incorporates the same signal processing and data treatment algorithms that are in software version 4.30).

minus value = -0.2 mg/cm^2
plus value = +0.0 mg/cm^2

Use the following calibration check tolerance values for *Fixed Mode* readings for those instruments with software versions earlier than version 4.1.

minus value = -0.2 mg/cm^2
plus value = +0.1 mg/cm^2

(Operators may choose to use limits in the manufacturer's operations manual for this calibration check. The rate of an incorrect result if the limits in the manufacturer's operations manual are followed may be different from the rate of an incorrect result stated here.)

FOR XRF RESULTS BELOW 4.0 mg/cm^2, SUBSTRATE CORRECTION RECOMMENDED FOR:

For those instruments with software versions 4.1 to 4.30. (This guidance may be used for software versions higher than 4.30 if the higher software version incorporates the same signal processing and data treatment algorithms that are in software version 4.30).

none

For those instruments with software versions earlier than version 4.1

Metal

SUBSTRATE CORRECTION NOT RECOMMENDED FOR:

For those instruments with software versions 4.1 to 4.30.

Brick, Concrete, Drywall, Metal, Plaster, and Wood

negative if they are less than or equal to the lower limit of the inconclusive range. Thresholds and inconclusive ranges reported here were determined for comparing results to the 1.0 mg/cm^2 standard. For a listing of laboratories recommended by the EPA National Lead Laboratory Accreditation Program (NLLAP) for the analysis of samples to resolve an inconclusive XRF result or additional confirmational analysis, call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

For those instruments with software versions 4.1 to 4.30. (This guidance may be used for software versions higher than 4.30 if the higher software version incorporates the same signal processing and data treatment algorithms that are in software version 4.30).

15-SECOND FIXED MODE READING DESCRIPTION	SUBSTRATE	THRESHOLD (mg/cm^2)	INCONCLUSIVE RANGE (mg/cm^2)
Results not corrected for substrate bias	Brick	None	0.9 to 1.1
	Concrete	None	0.9 to 1.1
	Drywall	None	0.9 to 1.1
	Metal	None	0.9 to 1.2
	Plaster	1.0	None
	Wood	None	0.9 to 1.1

BRIEF MODE READING DESCRIPTION	SUBSTRATE	THRESHOLD in mg/cm^2
Results not corrected for substrate bias	Brick	1.0
	Concrete	1.0
	Drywall	1.0
	Metal	1.0
	Plaster	1.0
	Wood	1.0

For those instruments with software versions earlier than version 4.1.

15-SECOND FIXED MODE READING DESCRIPTION	SUBSTRATE	INCONCLUSIVE RANGE in mg/cm^2
Results corrected for substrate bias for readings on metal substrates only	Brick	0.9 to 1.3
	Concrete	0.9 to 1.3
	Drywall	0.9 to 1.1
	Metal	0.9 to 1.1
	Plaster	0.9 to 1.1
	Wood	0.9 to 1.1

INSTRUCTIONS FOR EVALUATING XRF TESTING:

Chapter 7 of the HUD Guidelines recommends several options for evaluating XRF testing. Among those options is the following procedure which may be used after XRF testing has been completed. In single-family housing, an XRF result is the average of three readings taken on a testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). In multifamily housing, an XRF result is a single reading taken on a testing combination. If a multifamily

XRF PERFORMANCE CHARACTERISTICS SHEET
Advanced Detectors; LeadStar

TESTING TIMES:

For *Fixed Mode*, the LeadStar instrument tests for a set length of time before a result is obtained and displayed. For *Brief Mode*, the LeadStar instrument tests until a reading is obtained relative to an operator set *Action Level*. The following table provides a summary of testing times for readings taken in *Brief Mode* with an *Action Level* set to 1.0 mg/cm^2. All times have been scaled relative to an initial source strength of 15 mCi. Note that source strength and factors such as substrate may affect testing times.

Results from testing in August 1996 and September 1996

BRIEF MODE TESTING TIMES* (Seconds)						
SUBSTRATE	ALL DATA			MEDIAN FOR LABORATORY-MEASURED LEAD LEVELS (mg/cm^2)		
	25th Percentile	Median	75th Percentile	Pb < 0.25	0.25 ≤ Pb < 1.0	1.0 ≤ Pb
Wood Drywall	7	7	8	7	8	7
Metal	7	7	8	7	8	7
Brick Concrete Plaster	8	8	9	8	8	8

*Testing times are based on readings obtained relative to a 1.0 mg/cm^2 *Action Level*.

XRF PERFORMANCE CHARACTERISTICS SHEET
Advanced Detectors; LeadStar

For those instruments with software versions earlier than version 4.1.

FIXED MODE READINGS MEASURED AT	SUBSTRATE	BIAS (mg/cm^2)	PRECISION* (mg/cm^2)
0.0 mg/cm^2	Brick	0.1	0.1
	Concrete	0.1	0.1
	Drywall	0.0	0.1
	Metal	0.1	0.1
	Plaster	0.0	0.1
	Wood	0.0	0.1
0.5 mg/cm^2	Brick	0.2	0.2
	Concrete	0.2	0.2
	Drywall	0.1	0.2
	Metal	0.2	0.2
	Plaster	0.1	0.2
	Wood	0.1	0.2
1.0 mg/cm^2	Brick	0.3	0.3
	Concrete	0.3	0.3
	Drywall	0.1	0.3
	Metal	0.2	0.3
	Plaster	0.1	0.3
	Wood	0.1	0.3
2.0 mg/cm^2	Brick	0.4	0.5
	Concrete	0.4	0.5
	Drywall	0.3	0.5
	Metal	0.4	0.5
	Plaster	0.3	0.5
	Wood	0.3	0.5

*Precision at 1 standard deviation

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets, and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristics Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7 of the *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead-Based Paint Abatement and Poisoning Prevention, U.S. Department of Housing and Urban Development, Room B-133, 451 Seventh St. S.W., Washington, DC 20410.

XRF PERFORMANCE CHARACTERISTICS SHEET
Scitec Corporation; MAP-3

XRF CALIBRATION CHECK:

Chapter 7 of the HUD Guidelines recommends using a calibration check procedure to determine the operating condition of the XRF instrument. If the observed calibration check average minus 1.02 mg/cm^2 is greater than the positive (plus) calibration check tolerance value, or less than the negative (minus) calibration check tolerance value, then the instructions provided by the manufacturer should be followed in order to bring the instrument back into control before any more XRF testing is done. This calibration check is estimated to produce an incorrect result (that is, a finding that the instrument is out of calibration) very infrequently - once out of every 200 times this procedure is followed.

15-SECOND READINGS	60-SECOND READINGS
minus value = -0.6 mg/cm^2 plus value = +0.3 mg/cm^2	minus value = -0.4 mg/cm^2 plus value = +0.1 mg/cm^2

FOR XRF RESULTS BELOW 4.0 mg/cm^2, SUBSTRATE CORRECTION RECOMMENDED FOR:

Metal and Wood

SUBSTRATE CORRECTION NOT RECOMMENDED FOR:

Brick, Concrete, Drywall, and Plaster

SUBSTRATE CORRECTION VALUE COMPUTATION:

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bias. Supplemental guidance for using the red (1.02 mg/cm^2) NIST SRM paint film for substrate correction is provided below.

XRF results are corrected for substrate bias by subtracting from each XRF result a correction value determined separately in each house for single-family housing or in each development for multifamily housing, for each substrate. The correction value is an average of XRF readings taken over red NIST SRM (1.02 mg/cm^2) paint films at test locations that had been scraped clean of their paint covering. Compute the correction values as follows:

- Using the same XRF instrument, take three readings on a bare substrate area covered with the red NIST SRM (1.02 mg/cm^2) paint film. Repeat this procedure by taking three more readings on a second bare substrate area of the same substrate covered with the red NIST SRM (1.02 mg/cm^2) paint film.

- Compute the correction value for each substrate type by computing the average of all six readings as shown below.

housing development is being retested, randomly select two units from within the development from which the ten testing combinations should be randomly selected. Use either 15-second readings or 60-second readings.

Randomly select ten testing combinations for retesting from each house or from the two selected units.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family housing a result is defined as the average of three readings. In multifamily housing, a result is a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Compute the square of each of the ten original and ten retest XRF results.

Add these squares of XRF results together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the overall average of all ten original XRF results over all ten testing combinations selected for retesting.

Compute the overall average of all ten retest XRF results over all ten testing combinations selected for retesting.

Take the difference of the overall average of the ten original XRF results and the overall average of the ten retest XRF results. If the difference is negative, drop the negative sign.

If the difference of the overall averages is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

XRF PERFORMANCE CHARACTERISTICS SHEET
Scitec Corporation; MAP-3

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristics Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7 of the *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead-Based Paint Abatement and Poisoning Prevention, U.S. Department of Housing and Urban Development, Room B-133, 451 Seventh St. S.W., Washington, DC 20410.

XRF PERFORMANCE CHARACTERISTICS SHEET
Princeton Gamma-Tech, Inc.; XK-3

XRF CALIBRATION CHECK:

Chapter 7 of the HUD Guidelines recommends using a calibration check procedure to determine the operating condition of the XRF instrument. For this instrument, calibration check readings should be taken on wood. If the observed calibration check average minus 1.02 mg/cm^2 is greater than the positive (plus) calibration check tolerance value, or less than the negative (minus) calibration check tolerance value, then the instructions provided by the manufacturer should be followed in order to bring the instrument back into control before any more XRF testing is done. Testing must cease for those instruments with readings that exceed the calibration check tolerance limits in accordance with manufacturer's specifications. This calibration check is estimated to produce an incorrect result (that is, a finding that the instrument is out of calibration) very infrequently - once out of every 200 times this procedure is followed.

minus value = -0.5 mg/cm^2
plus value = +1.3 mg/cm^2

(Operators may choose to use the limits in the manufacturer's instruction manual for this calibration check. The rate of an incorrect result if the limits in the manufacturer's instruction manual are followed may be different from the rate of an incorrect result stated here).

FOR XRF RESULTS BELOW 4.0 mg/cm^2, SUBSTRATE CORRECTION RECOMMENDED FOR:

Brick, Concrete, Drywall, Metal, Plaster, and Wood.

SUBSTRATE CORRECTION NOT RECOMMENDED FOR:

None.

SUBSTRATE CORRECTION VALUE COMPUTATION:

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bias. Supplemental guidance for using the red (1.02 mg/cm^2) NIST SRM paint film for substrate correction is provided below.

XRF results are corrected for substrate bias by subtracting from each XRF result a correction value determined separately in each house for single-family housing or in each development for multifamily housing, for each substrate. The correction value is an average of XRF readings taken over red NIST SRM (1.02 mg/cm^2) paint films at test locations that had been scraped clean of their paint covering. Compute the correction values as follows:

- Using the same XRF instrument, take three readings on a bare substrate area covered with the red NIST SRM (1.02 mg/cm^2) paint film. Repeat this procedure by taking three more readings on a second bare substrate area of the same substrate covered with the red NIST SRM (1.02 mg/cm^2) paint film.

the ten testing combinations should be randomly selected.

Randomly select ten testing combinations for retesting from each house or from the two selected units.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and repeat XRF readings. Do not correct the original or retest results for substrate bias. In single-family housing a result is defined as the average of three readings. In multifamily housing, a result is a single reading. Therefore, there will be ten original and ten repeat XRF results for each house or for the two selected units.

Compute the square of each of the ten original and ten repeat XRF results.

Add these squares of XRF results together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the overall average of all ten original XRF results over all ten testing combinations selected for retesting.

Compute the overall average of all ten repeat XRF results over all ten testing combinations selected for retesting.

Take the difference of the overall average of the ten original XRF results and the overall average of the ten repeat XRF results. If the difference is negative, drop the negative sign.

If the difference of the overall averages is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

XRF PERFORMANCE CHARACTERISTICS SHEET
TN Technologies (TN Spectrace); Pb Analyzer

EFFECTIVE DATE: October 31, 1995 **EDITION NO.**: 1

MANUFACTURER AND MODEL:

Manufacturer:	*TN Technologies, Inc. (TN Spectrace)*
Make:	*Pb Analyzer*
Model:	*9292*
Source:	Cd^{109}
Note:	This sheet supersedes all previous sheets for the XRF instrument of the make, model, and source shown above.

EVALUATION DATA SOURCE AND DATE:

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated from evaluation data collected during the EPA/HUD field evaluation study conducted from March through October 1993 and from data collected during testing on the EPA/HUD archived building components in January 1995 and in September 1995. The field evaluation data were collected from approximately 1,200 test locations using two instruments both with radiation sources installed in April 1993. The results of this study are reported in *A Field Test of Lead-Based Paint Testing Technologies: Technical Report*, EPA 747-R-95-002b, May 1995. The archive testing data were collected from approximately 150 test locations using two instruments. The instrument that was used in January had a radiation source installed in July 1994 and the instrument that was used in September 1995 had a radiation source installed in January 1995. All of the aforementioned instruments had 30 mCi initial strengths.

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS:

Performance parameters shown in this sheet are applicable only when operating the instrument under the same conditions as the evaluation testing and using the procedures described in Chapter 7 of the HUD Guidelines. Operating parameters include:

- Manufacturer-recommended warm-up and quality control procedures
- Use the Multifamily Decision Flowchart for determining the presence of lead on a component type in multifamily housing
- Nominal 15-second readings on three locations per component for single-family housing and one location per component for multifamily housing
- Calibration checks are taken using the red (1.02 mg/cm^2) NIST Standard Reference Material (SRM No. 2579) paint film
- Lead-based paint is defined as paint with lead equal to or in excess of 1.0 mg/cm^2

XRF PERFORMANCE CHARACTERISTICS SHEET
TN Technologies (TN Spectrace); Pb Analyzer

INSTRUCTIONS FOR EVALUATING XRF TESTING:

Chapter 7 of the HUD Guidelines for recommends several options for evaluating XRF testing. Among those options is the following procedure which may be used after XRF testing has been completed. In single-family housing, an XRF result is the average of three readings taken on a testing combination. (A testing combination is a location on a painted surface as defined in Chapter 7 of the HUD Guidelines). In multifamily housing, an XRF result is a single reading taken on a testing combination. If a multifamily housing development is being retested, randomly select two units from within the development from which the ten testing combinations should be randomly selected.

Randomly select ten testing combinations for retesting from each house or from the two selected units.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family housing a result is defined as the average of three readings. In multifamily housing, a result is a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Compute the square of each of the ten original and ten retest XRF results.

Add these squares of XRF results together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the overall average of all ten original XRF results over all ten testing combinations selected for retesting.

Compute the overall average of all ten retest XRF results over all ten testing combinations selected for retesting.

Take the difference of the overall average of the ten original XRF results and the overall average of the ten retest XRF results. If the difference is negative, drop the negative sign

If the difference of the overall averages is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the

XRF PERFORMANCE CHARACTERISTICS SHEET
TN Technologies (TN Spectrace); Pb Analyzer

A document titled *Methodology for XRF Performance Characteristic Sheets* provides an explanation of the statistical methodology used to construct the data in the sheets, and provides empirical results from using the recommended inconclusive ranges or thresholds for specific XRF instruments. For a copy of this document call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

This XRF Performance Characteristics Sheet is a joint product of the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Housing and Urban Development (HUD). The issuance of this sheet does not constitute rulemaking. The information provided here is intended solely as guidance to be used in conjunction with Chapter 7 of the *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing*. EPA and HUD reserve the right to revise this guidance. Please address questions and comments on this sheet to: Director, Office of Lead-Based Paint Abatement and Poisoning Prevention, U.S. Department of Housing and Urban Development, Room B-133, 451 Seventh St. S.W., Washington, DC 20410.

XRF PERFORMANCE CHARACTERISTICS SHEET
Princeton Gamma-Tech, Inc.; XK-3

XRF CALIBRATION CHECK:

Chapter 7 of the HUD Guidelines recommends using a calibration check procedure to determine the operating condition of the XRF instrument. For this instrument, calibration check readings should be taken on wood. If the observed calibration check average minus 1.02 mg/cm^2 is greater than the positive (plus) calibration check tolerance value, or less than the negative (minus) calibration check tolerance value, then the instructions provided by the manufacturer should be followed in order to bring the instrument back into control before any more XRF testing is done. Testing must cease for those instruments with readings that exceed the calibration check tolerance limits in accordance with manufacturer's specifications. This calibration check is estimated to produce an incorrect result (that is, a finding that the instrument is out of calibration) very infrequently - once out of every 200 times this procedure is followed.

minus value =	-0.5 mg/cm^2
plus value =	+1.3 mg/cm^2

(Operators may choose to use the limits in the manufacturer's instruction manual for this calibration check. The rate of an incorrect result if the limits in the manufacturer's instruction manual are followed may be different from the rate of an incorrect result stated here).

FOR XRF RESULTS BELOW 4.0 mg/cm^2, SUBSTRATE CORRECTION RECOMMENDED FOR:

Brick, Concrete, Drywall, Metal, Plaster, and Wood.

SUBSTRATE CORRECTION NOT RECOMMENDED FOR:

None.

SUBSTRATE CORRECTION VALUE COMPUTATION:

Chapter 7 of the HUD Guidelines provides guidance on correcting XRF results for substrate bias. Supplemental guidance for using the red (1.02 mg/cm^2) NIST SRM paint film for substrate correction is provided below.

XRF results are corrected for substrate bias by subtracting from each XRF result a correction value determined separately in each house for single-family housing or in each development for multifamily housing, for each substrate. The correction value is an average of XRF readings taken over red NIST SRM (1.02 mg/cm^2) paint films at test locations that had been scraped clean of their paint covering. Compute the correction values as follows:

- Using the same XRF instrument, take three readings on a bare substrate area covered with the red NIST SRM (1.02 mg/cm^2) paint film. Repeat this procedure by taking three more readings on a second bare substrate area of the same substrate covered with the red NIST SRM (1.02 mg/cm^2) paint film.

the ten testing combinations should be randomly selected.

Randomly select ten testing combinations for retesting from each house or from the two selected units.

Conduct XRF retesting at the ten testing combinations selected for retesting.

Determine if the XRF testing in the units or house passed or failed the test by applying the steps below.

Compute the Retest Tolerance Limit by the following steps:

Determine XRF results for the original and repeat XRF readings. Do not correct the original or retest results for substrate bias. In single-family housing a result is defined as the average of three readings. In multifamily housing, a result is a single reading. Therefore, there will be ten original and ten repeat XRF results for each house or for the two selected units.

Compute the square of each of the ten original and ten repeat XRF results.

Add these squares of XRF results together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the overall average of all ten original XRF results over all ten testing combinations selected for retesting.

Compute the overall average of all ten repeat XRF results over all ten testing combinations selected for retesting.

Take the difference of the overall average of the ten original XRF results and the overall average of the ten repeat XRF results. If the difference is negative, drop the negative sign.

If the difference of the overall averages is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

XRF PERFORMANCE CHARACTERISTICS SHEET
Niton Corporation; XL-309 Spectrum Analyzer

EFFECTIVE DATE: August 24, 1995 **EDITION NO.:** 1

MANUFACTURER AND MODEL:

Make:	*Niton Corporation*
Model:	*XL-309 Spectrum Analyzer*
Source:	Cd^{109}
Note:	This sheet supersedes all previous sheets for the XRF instrument of the make, model, source, and software versions shown above.

EVALUATION DATA SOURCE AND DATE:

This sheet is supplemental information to be used in conjunction with Chapter 7 of the HUD *Guidelines for the Evaluation and Control of Lead-Based Paint Hazards in Housing* ("HUD Guidelines"). Performance parameters shown on this sheet are calculated from the EPA/HUD evaluation using archived building components. Testing was conducted March 1995 on approximately 150 test locations using a single instrument with an October 1994 source at 10 mCi initial strength while running software version 1.2C. These results supersede the 1993 testing of XL prototypes reported in the document titled: *A Field Test of Lead-Based Paint Testing Technologies.*

FIELD OPERATION GUIDANCE

OPERATING PARAMETERS:

Performance parameters shown in this sheet are applicable only when operating the instrument under the same conditions as the evaluation testing and using the procedures described in Chapter 7 of the HUD Guidelines. Operating parameters include:

- Manufacturer-recommended warm-up and quality control procedures
- Use the Multifamily Decision Flowchart for determining the presence of lead on a component type in multifamily housing
- Nominal 20-second readings for L-shell results or 120-second readings for K-shell results on three locations per component for single-family housing and one location per component for multifamily housing
- Calibration checks are taken using the red (1.02 mg/cm^2) NIST Standard Reference Material (SRM No. 2579) paint film
- Lead-based paint is defined as paint with lead equal to or in excess of 1.0 mg/cm^2.

XRF PERFORMANCE CHARACTERISTICS SHEET
Niton Corporation; XL-309 Spectrum Analyzer

XRF CALIBRATION CHECK:

Chapter 7 of the HUD Guidelines recommends using a calibration check procedure to determine the operating condition of the XRF instrument. If the observed calibration check average minus 1.02 mg/cm^2 is greater than the positive (plus) calibration check tolerance value, or less than the negative (minus) calibration check tolerance value, then the instructions provided by the manufacturer should be followed in order to bring the instrument back into control before any more XRF testing is done. This calibration check is estimated to produce an incorrect result (that is, a finding that the instrument is out of calibration) very infrequently - once out of every 200 times this procedure is followed.

minus value = -0.1 mg/cm^2
plus value = +0.1 mg/cm^2

FOR XRF RESULTS BELOW 4.0 mg/cm^2, SUBSTRATE CORRECTION RECOMMENDED FOR:

None

SUBSTRATE CORRECTION NOT RECOMMENDED FOR:

Brick, Concrete, Drywall, Metal, Plaster, and Wood

HOW TO CLASSIFY READINGS:

This section describes how to apply the readings and other information displayed by this instrument to determine the presence or absence of lead in paint using the procedures recommended in Chapter 7 of the HUD Guidelines. These guidelines recommend classifying XRF results as positive, negative, or inconclusive compared to the 1.0 mg/cm^2 standard. But because this instrument displays readings and ancillary information useful for classification purposes, an algorithmic procedure is described that makes use of not only the XRF reading but some of the other displayed information as well.

As detailed below, the algorithm for classifying results is first applied to 20-second nominal L-shell readings followed by 120-second nominal K-shell readings to resolve inconclusive results and laboratory analysis of paint-chip samples, if necessary. For a listing of laboratories recommended by the EPA National Lead Laboratory Accreditation Program (NLLAP) for the analysis of samples to perform additional confirmational analysis, call the National Lead Information Center Clearinghouse at 1-800-424-LEAD.

XRF results are classified using threshold values. For the XL-309, threshold values are the only values provided for classifying results. Results are classified as positive if they are greater than or equal to the threshold, and as negative if they are less than the threshold. There is no inconclusive classification when using threshold values. However, inconclusive results still may be obtained regardless of whether decisions are based on L-shell readings, K-shell readings, or both, as described below. Use all digits that are reported by the instrument. Threshold values, which were determined for comparing results to the 1.0 mg/cm^2 standard, are provided in the following table.

- Classify the L-reading as INCONCLUSIVE if the numerical result that follows the greater than symbol is less than 1.0.

If the numerical L-reading is displayed alone (that is, without any preceding greater-than symbols) then:

- Classify the L-reading as POSITIVE if the numerical result is equal to or greater than 1.0.
- Classify the L-reading as NEGATIVE if the numerical result is less than 1.0.

C. Resolution of results classified as inconclusive.

All results classified as inconclusive above require further investigation. Take a 120-second nominal XRF reading and use the K-shell reading. In multifamily housing, resolve the inconclusive classification with a single K-shell reading or laboratory analysis as described below.

- Classify the result as POSITIVE if either the K-reading minus the displayed precision value or the lower K-reading is equal to or greater than 1.0.
- Classify the result as NEGATIVE if either the K-reading plus the displayed precision value or the upper K-reading is less than 1.0.
- Classify the result as INCONCLUSIVE if neither of the above decision rules using the K-reading provided a classification which can occur when the upper K-reading is equal to or greater than 1.0 or the lower K-reading is less than 1.0.
- To resolve a remaining INCONCLUSIVE classification, remove a paint-chip sample and have it analyzed in a laboratory as described in Chapter 7 of the HUD Guidelines.

SINGLE-FAMILY HOUSING XRF RESULT CLASSIFICATIONS:

D. Take three 20-second nominal readings on each testing combination.

E. Classify each L-reading using the methodology described in item A under Multifamily Housing XRF Result Classifications.

F. Classification of the XRF result for a given testing combination is obtained by combining the individual results of the three L-shell readings as follows:

- A POSITIVE classification is obtained if at least two of the three individual L-readings are classified as positive.
- A NEGATIVE classification is obtained if at least two of the three individual L-readings are classified as negative.

XRF PERFORMANCE CHARACTERISTICS SHEET
Niton Corporation; XL-309 Spectrum Analyzer

Determine XRF results for the original and retest XRF readings. Do not correct the original or retest results for substrate bias. In single-family housing a result is defined as the average of three readings. In multifamily housing, a result is a single reading. Therefore, there will be ten original and ten retest XRF results for each house or for the two selected units.

Compute the square of each of the ten original and ten retest XRF results.

Add these squares of XRF results together. Call this quantity C.

Multiply the number C by 0.0072. Call this quantity D.

Add the number 0.032 to D. Call this quantity E.

Take the square root of E. Call this quantity F.

Multiply F by 1.645. The result is the Retest Tolerance Limit.

Compute the overall average of all ten original XRF results over all ten testing combinations selected for retesting.

Compute the overall average of all ten retest XRF results over all ten testing combinations selected for retesting.

Take the difference of the overall average of the ten original XRF results and the overall average of the ten retest XRF results. If the difference is negative, drop the negative sign.

If the difference of the overall averages is less than the Retest Tolerance Limit, the inspection has passed the retest. If the difference of the overall averages equals or exceeds the Retest Tolerance Limit, this procedure should be repeated with ten new testing combinations. If the difference of the overall averages is equal to or greater than the Retest Tolerance Limit a second time, then the inspection should be considered deficient.

Use of this procedure is estimated to produce a spurious result approximately 1% of the time. That is, results of this procedure will call for further examination when no examination is warranted in approximately 1 out of 100 dwelling units tested.

Appendix B: HUD Soil Sampling Protocol

Appendix 13.3: Soil Sampling Protocol For Housing

A. Collection Technique General Description

Bare soil samples are typically collected with a coring device or a scooping technique. The device may be used in either of two ways. Most coring devices come equipped with a "T" handle which can be attached to the top of the coring tool or probe. This allows the operator to push the tool into the ground. The coring tool can be twisted with the "T" handle as it is pushed into the ground in order to allow the cutting edge of the soil probe to cut through roots and packed earth. In softer soils, a disposable new plastic syringe at least ½ inch diameter can be used for each composite sample

The other method for using the coring tool is to attach a hammer device to the top of the coring tool. To utilize the coring tool in this manner, the hammer device is first attached to the top of the coring tool and the tip of the probe is placed on the ground where the sample is to be collected. The hammer is then raised and allowed to fall while it is guided by the operator's hands. The hammer attachment may be the most appropriate tool when the nature of the soils is hard and compacted. Otherwise the "T" handle is easier to use.

The soil samples are collected by driving or pushing the coring tool into the ground, usually about ½ inch deep. The tool is then moved gently from side to side to loosen a plug of soil. The tool is then pulled from the ground and the soil sample is pushed so that the upper part of the soil plug lies between one inch marks made on the coring device. The top one half inch of the soil sample is then cut from the core with a stainless steel knife or cutting tool provided for that purpose. This top one half inch section of the soil core is then transferred to a sample container. All sub-samples are collected in this manner. The collection of subsamples from the sampling line is referred to as a "composite" sample.

After collecting a composite sample, the soil probe should be decontaminated or discarded if disposable core liners are used. This process consists of wiping the end of the probe with wet wipes until no more visible dirt is removed from the probe. Similar cores are then collected from the bottom inch of the six-inch core.

B. Materials and Supplies

1. Core sampling device: Standard soil coring device. Other similar core sampling devices may be used, such as disposable plastic syringes with the end cut off. The plunger is used to remove the soil from the syringe body.

2. Disposable wipes.

3. Non-sterilized 5" x 8" plastic ziplock baggies: Unless baggies are 4 mil industrial strength, they must be double bagged

Appendix C: Electronic Data Submittal Example

Electronic Data Submittal
SFUSD Lead Poisoning Prevention Program
Updated 5/1/97

													Priority Factors					
Cam #	Priority	Sample ID	Floor	Bldg	Space	Side	Structure	Feature	Substrate	Result	PPM or mg/cm2	Color	>1mg/cm2 or>5000 ppm	>600 PPM	Soil/Surface/ Water contamination	Loose/Peeling	Child Accessible	Space/Object used by children

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